Annual Report 2005

HELSINKI INSTITUTE OF PHYSICS

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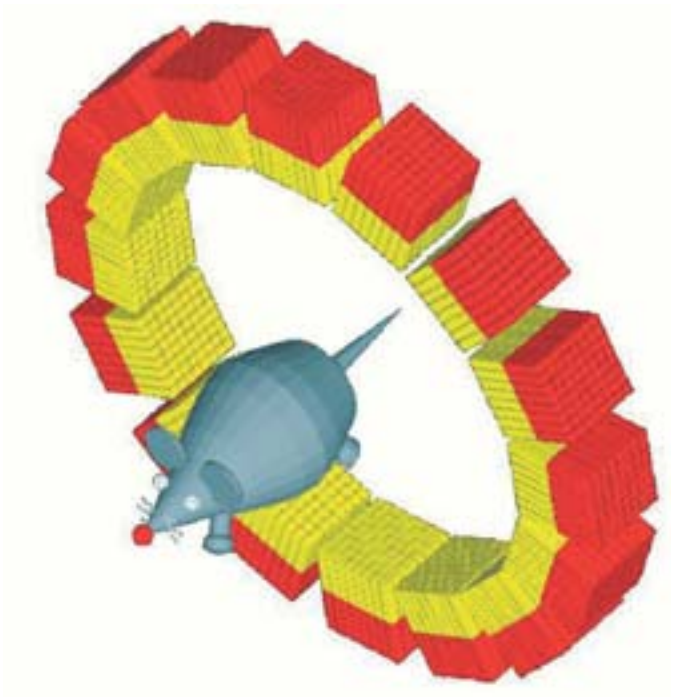

Geant4 is a showcase example of technology transfer from particle physics to other fields such as medical imaging. Simulation of a small PET scanner using Geant4. (Courtesy of the OpenGate Collaboration.)

Annual Report 2005 Helsinki Institute of Physics

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Introduction

Dan-Olof Riska

The Helsinki Institute of Physics (HIP) is a national Finnish institute for research in physics and physics related technology development. The Institute is operated jointly by the Universities of Helsinki and Jyväskylä and the Helsinki University of Technology. The Institute has a mandate from the Finnish Ministry of Education for coordinating the Finnish research at CERN.

In 2005 the Institute has been responsible for the planning of the Finnish collaboration with the Facility for Antiproton and Ion Research FAIR that will be constructed as an international facility at the GSI Accelerator Laboratory in Darmstadt.

The modus operandi of the Institute is to carry out time limited significant research projects that are either too resource intensive or too cross disciplinary or novel to fit into the standard framework for the funding of academic research in Finland. An important task of the Institute is to support the research and teaching departments in its member universities by means of joint research projects and by graduate training within these research projects. An example of the success of this collaboration is the fact that 14 project leaders and researchers of the Institute have been appointed to professorial positions at several different universities both in Finland and abroad. Another three have been appointed to university lecturer positions.

The Theory Programme of the Institute serves as a Finnish project oriented national institute for theoretical physics. During the year the Theory Programme included the following five projects: (1) string theory and quantum field theory, (2) the physics of biological systems, (3) the theory of ultrarelativistic heavy ion collisions, (4) cosmology and (5) particle physics phenomenology. As a consequence of a very positive review by the Scientific Advisory Board the projects on cosmology and particle physics phenomenology were granted continuation until the end of 2007 by the Board of the Institute. During the year the leader of the particle physics phenomenology project, Dr. Katri Huitu, was appointed to a professorship at the University of Helsinki. In 2005 the leader of the project on the physics of biological systems, Dr. Ilpo Vattulainen was appointed professor at the Tampere University of Technology, and he was the recipient of the Academy of Finland Incentive Award.

The High Energy Physics Programme continued its projects for detector development for the forward proton-proton physics study in the TOTEM experiment at the LHC at CERN and at the CDF-II experiment at the Tevatron accelerator at the Fermi National Accelerator Laboratory. A memorandum-of-understanding was signed with the CTF3 collaboration for a contribution to the CERN linear collider project.

The research programme for the CMS detector is divided into two projects: one for the development and construction of the tracker and the trigger of the CMS detector at the LHC and the other for software development for the CMS data analysis and studies of the discovery potential of the CMS experiment. Detector R&D for the LHC upgrade is conducted under the auspices of the Tracker project.

The Nuclear Matter Programme of the Institute was divided into 2 projects. The

first is a nuclear structure research project at the ISOLDE facility at CERN. The second is a project for physics analysis at and instrumentation for the ALICE detector for relativistic heavy ion collisions at the LHC. Separate funding was obtained for planning the Finnish contribution to the GSI/FAIR project.

The Technology Programme of the Institute aims to develop industrial applications for CERN generated innovations in technology. During 2005 the focus of the Technology Programme was on software development for distributed data-intensive Grid computation. The project is the Finnish member of the European Union funded Enabling Grids in E-sciencE project and an associate to the new CERN OpenLab for Grid applications project. In the second phase of this project, EGEE-II, the Finnish IT center for science CSC has joined with the Institute. The Programme has signed a memorandum-of-understanding with CSC for this purpose. The Technology Programme administers a project "Netgate" supported by the National Technology Agency of Finland TEKES for collaboration on the development of Grid technology for industry. Among the collaborating companies are F-secure, Nokia and Stonesoft.

The Institute is the Finnish partner of the LHC Computing Grid Project at CERN (LCG-1) for the establishment of the distributed high-throughput computing capacity that will be required by the analysis of the data obtained by the LHC detectors.

In 2005 those components and activities of the Institute which have a clear association with the University of Helsinki were evaluated by an international panel as a part of the quintennial review of the University. The panel gave the Institute a laudatory report and the top performance score. As a consequence the University of Helsinki rewards the Institute with a financial performance award for the following 6 year period.

The Institute has continued its strong efforts in graduate student training in frontline research. This activity is supported in part by the research projects themselves, and in part by the national graduate school programmes. The graduate training efforts were greatly strengthened by generous grants by several Finnish foundations, first and foremost by the Magnus Ehrnrooth Foundation. During 2005 6 PhD and DSc degrees and 10 MSc degrees were awarded on the basis of research conducted within the research projects of the Institute.

The summer student programme at CERN continues to be a highly significant component of the educational efforts of the Institute. In 2005, 16 Finnish students spent three months at CERN working in HIP research programmes. An important outreach activity is the arrangement of science education sessions for Finnish high schools at CERN. During the year 12 Finnish groups of high school students and one group of high school teachers in Finnish "gymnasiums" were given such training sessions at CERN.

The very successful collaboration between the Institute and the Finpro organization for enhancing the collaboration between CERN and Finnish industry continued in 2005. This effort was supported by the National Technology Agency TEKES.

HIP is governed by a tripartite board appointed by the universities that operate the Institute. During the year the Board was chaired by Vice Rector Marja Makarow of the University of Helsinki. The scientific activities of the Institute were overseen by an international Scientific Advisory Board, which was chaired by the director of the Physics Department at CERN, Dr. Wolf-Dieter Schlatter.

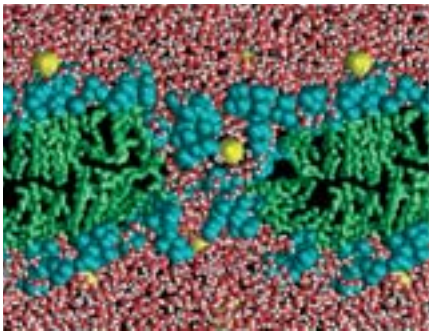
HELSINKI INSTITUTE OF PHYSICS

Highlights of Research Results

Theory Programme

In Cosmology a completely covariant formalism, valid to all orders, was developed for the treatment of the curvature perturbation. We have considered the generation of non-Gaussian perturbations during preheating, in string motivated inflation models ending via tachyonic instability, and in self-interacting curvaton models. In collaboration with the Department of Physical Sciences, the Cosmology project continued to participate in the Finnish Planck Surveyor Consortium.

In Particle Physics Phenomenology, for the first time a supersymmetric model was constructed where both CP-symmetry and R-parity are broken by the properties of the vacuum. In this model the constraints on the mass differences and mixing angles in the neutrino sector, as well as the constraints from electric dipole moments can be fulfilled. The Higgs detection possibilities at the LHC were considered: a new process was analyzed and found useful, and high scale nonuniversalities were found to imply changes in the search strategy.



The Biophysics group published pioneering computational results on a number of research topics, including glycolipids, dielectrophoresis and lipoproteins. Together with five other groups at the Laboratory of Physics at the Helsinki University of Technology, it was chosen as a Centre of Excellence by the Academy of Finland for 2006–2011, and Ilpo Vattulainen together with the Biophysics group was awarded the Academy of Finland Incentive Award for 2005.

The String Theory and Quantum Field Theory group reported two novel conceptual ideas, both accepted for publication in Physical Review Letters. One of them is a new scenario for an initial condition for matter in a space-time where an unstable brane releases a large amount of energy in the form of closed string radiation. This process can be viewed as a string theoretic non-singular initial condition. The other new idea is the proposal of twisted Poincaré symmetry as the relativistic interpretation of noncommutative space-time. The new symmetry has far-reaching consequences in quantum field theory and gravity.

The Heavy Ion project has developed a successful description of transverse momentum spectra of hadrons in A+A collisions, based on perturbative QCD, nuclear parton distributions, gluon saturation, hydrodynamics and parton energy losses in QGP. Quark-antiquark production from classical gluons fields in primary A+A collisions has been studied in 1+1 and 1+3 dimensional cases and support for rapid thermalization has been obtained. Calculation of the hot QCD free energy up to g^6 is in progress and the Standard Model pressure at finite temperatures has been computed. Effective QCD-like theories have been developed further, also for the electroweak sector, with a suggestion of a light composite Higgs particle.

High Energy Physics Programme

The group of the High Energy Physics Programme has firmly established its physics analysis activities within the CDF experiment at Fermilab's Tevatron collider. This is complemented by operational maintenance and off-line quality control of the Silicon Vertex detector. Tuula Mäki is working on her PhD thesis on the top quark mass meas-

urement in the di-lepton decay channel using a Monte Carlo template method and lepton kinematics. Her results have been presented at several international conferences and workshops and will be submitted for publication in early 2006. The CDF combined top mass in the di-lepton channel amounts to 170.1 ± 6.0 (stat.) ± 4.1 (syst.) GeV/c^2. A top quark mass measurement in the all hadronic decay channel was initiated by the group in 2004. Petteri Mehtälä completed his MSc thesis on the subject in June 2005 with a grade of Laudatur and he is continuing the analysis for his PhD. The measurement, based on the *ideogram* technique originally developed in the DELPHI experiment, is now established and recognized within the CDF experiment and will be submitted to Particle Physics conferences in 2006.

During 2005, the Finnish TOTEM group has studied elaborate level-1 trigger schemes required both for the planned searches of the Higgs boson in the central exclusive diffraction (CED) and for the forward physics programme of the TOTEM experiment. An efficient trigger pattern based on the information from the T2 telescope of TOTEM has been devised by the group for the reconstruction of charged particles from the interaction point and thereby enabling efficient triggering of diffractive events at low-luminosity running of the LHC. In addition to its responsibilities in manufacturing the TOTEM T2 spectrometer and preparing the TOTEM trigger scenarios, the Helsinki group has key positions in preparing the physics programme of the TOTEM experiment and in establishing search strategies for the Higgs boson in the CED processes detected by the 420 m leading proton detectors.

More than two decades of Finnish activity in the DELPHI experiment at CERN's Large Electron Positron (LEP) collider is coming to an end. In 2005, the last two physics analyses of the Finnish DELPHI group were accepted for publication in the European Physical Journal and the last Finnish PhD thesis (Laura Salmi's) using the DELPHI data will be defended in spring 2006. Examples of the outcome of the DELPHI activity are about 300 physics articles published in refereed periodicals and about 20 Finnish PhD theses. The knowledge and expertise gained on analysis tools and detector building and operation form a solid base for the contributions to the TOTEM and CDF experiments, which will be the main activities of the Programme for the next few years.

In autumn 2005, a memorandum-of-understanding (MOU) on the Finnish contribution to a future collider, the Compact LInear Collider (CLIC) technology R&D programme was signed between HIP and CERN. The aim of the R&D programme is to demonstrate the feasibility of the proposed CLIC technology in view of a decision on a future linear collider in 2010. The group's CERN-based micromachining expert, Jukka Paro, is surveying different machining methods for prototypes of the CLIC accelerating structures as well as organizing the survey of the machined prototypes. Finnish industry has shown considerable interest in this development and in fact, a significant fraction of the accelerating structure prototypes are made by Finnish firms.

In 2005, the manufacturing and validation of the Gas Electron Multiplier based TOTEM T2 detectors in Helsinki was launched. Altogether 50 triple-GEM's will be constructed at the *Physicum Detector Laboratory* in Kumpula. Based on this project, the Helsinki group has gained the position of being one of the leading detector groups in GEM-based technologies. The Detector Laboratory premises were shared with the Silicon Strip Detector (SSD) module assembly project for the ALICE experiment and the CMS project finishing its carbon-fibre rod assembly for its SSD detectors. In order to improve the visibility of the Laboratory, in May 2005 a new website was established for the Detector Laboratory, which contains descriptions of the active projects.

In 2005, the generic detector development activity concentrated on building facilities and working procedures for the production of TOTEM-T2 GEM detectors. New devices and instruments were installed in the clean room to fulfil the requirements for a high-quality production line.

CMS Programme

In the preparation for the data taking activities of CMS a very important milestone is the Physics Technical Design Report, which provides an entry point to the documentation of the standard simulation, reconstruction, and analysis tools of CMS and provides a measure of its expected detector performance and physics reach. Volume 1 of this report is about to be published, after extensive progress in its writing in 2005. In this work the HIP team has been responsible for studying Higgs production in the three important decay channels $H \to \gamma\gamma$, $H/A \to \tau\tau$ and $H^{\pm} \to \tau\nu$. The team has benefited from the huge progress made in 2005 in the CMS Grid computing system, which allows a large volume of CMS simulation data to be effectively available for analysis. The HIP computing team also made important progress in maintaining and developing the Kumpula Linux clusters and disk servers as part of the CMS computing system. The team actively participated in the Finnish, Nordic and CMS Grid computing work.

As the CMS software is about to be ready for the beginning of the data analysis, the adoption of realistic calibration and alignment tools is becoming mandatory. Development of highly demanding track-based calibration algorithms for the geometric alignment of the CMS silicon detector modules is one of the critical ingredients in this preparation. Here the HIP team has played an important role and made essential contributions to the CMS misalignment simulation framework which is used for developing and testing the alignment algorithms and for studying the implications of misalignments to the physics results. The team continued the development and maintenance of the ”Hits and Impact Points” (H.I.P.) alignment algorithm. The algorithm was successfully applied to the alignment of the CMS Cosmic Rack, a minitracker mimicking a sector of the CMS Outer Barrel (TOB) tracker. The method was further developed for alignment studies of the simulated CMS Pixel detector.

It is important that in the final simulation studies of the LHC experiments as realistic as possible information about the detectors and the physics processes is used. Detailed simulation of the CMS experiment is based on the Geant4 toolkit. The HIP CMS team has significantly contributed to the design of the hadronic cascade models in this software framework. The release of newly designed hadronic cascade models in 2005 was one of the highlights of the Software project. Furthermore, HIP, together with SLAC, was entrusted with the responsibility for the co-ordination of the hadronic physics development in Geant4. The CMS Software and Physics group organized in June 2005 ”The 2nd Finnish Geant4 Workshop”, with 24 international participants.

Finland was chosen by CERN for the first time as the host country for the annually organized and highly appreciated ”CERN School of Computing”. The school is meant for postgraduate students and research workers with a few years of experience in elementary particle physics, in computing or in related fields. This 14-day school has been organized by CERN since the early eighties in several member countries. In 2006, HIP is the host institute of the school, which will take place at the Kumpula Campus. The Local Organization Committee consists of members of the HIP CMS Software and Physics project and of the HIP Technology Programme.

In the HIP CMS Tracker project an important milestone was reached as the Mechanics team successfully completed the design and construction of the high-precision, lightweight support structures (”rods”) for the CMS TOB detectors. In May 2005, the rod assembly work was completed at the Physicum laboratories in Kumpula. A total of 750 rod frames were manufactured, tested and delivered to CERN. Their integration into the CMS Tracker is now under way.

Another highlight in the Tracker project was the publication of the first-ever test beam results on a proton irradiated full-size Czochralski silicon (Cz-Si) particle detector. The detector was processed by the HIP CMS R&D team. It was irradiated with protons at the Accelerator Laboratory of the University of Jyväskylä and tested in the CERN H2 beam. The contributions of the R&D team in developing and testing new detectors for high luminosity collider experiments were recognized by the international RD50 collaboration as it decided to hold the 6th RD50 Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders at the Helsinki Institute of Physics in Kumpula. The workshop which had 40 participants took place on 2–4 June 2005.

Finally, an important milestone was the commissioning of the Finnish Cosmic Rack (FinnCRack) at CERN in summer 2005. For this operation FinnCRack was equipped with four CMS detector rods. The first tracks of cosmic muons were measured and the results were reported in conferences in autumn. The facility is to be moved to the Kumpula campus in spring 2006, where it will provide a test bench for studies of the TOB subsystem level functionality as well as for development of TOB readout software. It will be part of the infrastructure of the Detector Laboratory.

Nuclear Matter Programme

The Nuclear Matter Programme provides full participation of the Finnish teams at CERN in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with extreme composition of its proton and neutron numbers and hot and dense matter created in relativistic heavy ion collisions. In addition, the Nuclear Matter Programme is co-ordinating the Finnish participation in the planning of FAIR, the international Facility for Antiproton and Ion Research, at GSI.

The construction work for the ALICE experiment has intensified during 2005 on the eve of ALICE's start-up. The Finnish ALICE team has been successfully involved in assembling the tracker components, design and construction of the T0 detector and development of the track reconstruction software. The growing importance of physics and data analysis in the work of our group has been strengthened by the creation of a new research position at the University of Jyväskylä, paid jointly by HIP and JYFL. Furthermore, since the data analysis and the physics emerging from it will form the basis of continuing future activities, preparations for the computational infrastructure have been launched. This includes involvement in the national initiative towards a GRID infrastructure in Finland, involvement in the plans for the Nordic ALICE computing infrastructure and usage of the existing resources.

Kaons, being the lightest strange hadrons are expected to dominate the strange sector by virtue of canonical thermodynamics. With a significant kaon production at LHC energies, the reconstruction of the kink topology is a key technique for identifying kaons over a momentum range much wider than the one achieved by combining PID signals from different detectors. During the last year the Jyväskylä team has finalized the reconstruction algorithm and the physics analysis required to extract the expected yields of reconstructed kaon decays at the LHC. The results have been published in Vol. II of ALICE's Physics Performance Report.

The HIP-Jyväskylä team has chief responsibility for the T0 detector. The T0 performance has a direct impact on vertex determination, Time of Flight (TOF) results, operation of the Transition Radiation Detector, V0 monitoring, and data normalization. T0 together with V0 will play a dominant role already in extracting the so-called Day One Physics, this involves measurements of the pseudorapidity density $dN/d\eta$, p_T spectra, multiplicity distributions, dependence of mean transverse momentum on multiplicity etc. In June 2005, T0 completed the

Production Readiness Review receiving a green light for the production of all detector modules. An important milestone was crossed in November 2005 with the successful completion of the full chain electronics readout: the super-fast front-end electronics of T0 and readout electronics of the TOF detector were combined. As a result, the 28 ps resolution for 1 MIP was reproduced and 13.6 ps resolution for 30 MIP signals from the calibration laser was reached.

An important issue for ALICE Forward Detectors is radiation hardness. In August 2005 a series of irradiations were carried out at JYFL with a 60 MeV proton beam. This test has shown that the dose sufficient to kill the front-end electronics is of the order of 100 krad/cm^2 which is the expected integrated dose over a 10 year operation period of ALICE. Although 10 years of ALICE operations might be reached with the present electronics chain we are investigating several options to solve this possible problem.

The two largest layers of the ALICE Inner Tracking System (layers 5 & 6) will contain 1698 Silicon Strip Detector (SSD) modules. The production of these modules is shared between France, Italy and Finland. The assembly of the Finnish share of SSD modules is being done in the HIP Detector Laboratory (DL) in Helsinki in collaboration with 19 researchers from Kharkov and Kiev while the quality control of the SSD assemblies is being taken care of by the local group. Up to the end of 2005 a total of 530 SSD modules have been assembled in Helsinki containing over 0.8 million channels and 2.5 million individual single-point TAB (spTAB) interconnections. This makes the project the largest detector module assembly enterprise ever conducted in the history of Finnish science.

Extensive life-time acceleration studies for the components were performed throughout the year. If made correctly the spTAB interconnections will not fail during the expected ALICE operational lifetime of 10–15 years. Since the Helsinki Laboratory has been pioneering the bond process development and the SSD assembly within the collaboration, a paper based mainly on the Helsinki experience on the ALICE SSD assembly was presented at the LECC'05 Conference in Heidelberg in September. Within the quality control of the SSD assemblies a new non-destructive method for accessing the ultrasonic bond quality has been proposed. It uses a Scanning White-Light Interferometer to measure the height of the bond.

At ISOLDE diffusion studies employing the modified radiotracer technique were continued with ^{52}Mn and ^{54}Mn implantation in GaAs and $Si_{1-x}Ge_x$ alloys. Inclusion of magnetic impurities such as Mn at high concentrations in semiconductors offers good prospects for combining magnetic phenomena with high speed electronics and optoelectronics. In addition off-line implantation of radioactive ^{7}Be ions to Ge, $Si_{1-x}Ge_x$, glassy carbon and several metals was carried out, this is partly related to the ion source development work done at ISOLDE.

There are several Nuclear Physics studies currently being undertaken at ISOLDE. In our studies of light neutron-rich nuclei we have examined excited states in heavy Mg isotopes close

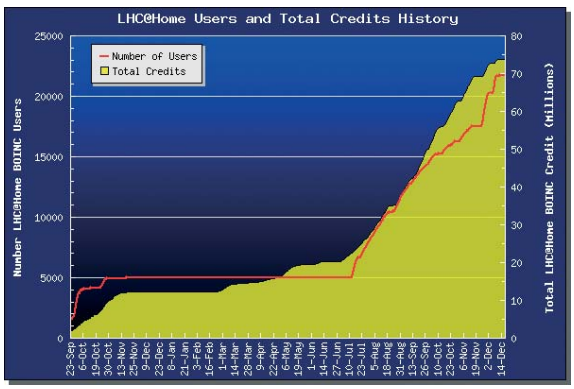
to the "island of inversion" by applying advanced timing techniques. Collaboration with the ISOLTRAP group continued in 2005. One of the experiments was devoted to measuring the masses of neutron-rich ^{71}Zn to ^{81}Zn isotopes with a high precision. An important factor in the success of this experiment was the good beam quality from ISOLDE due to a new quartz transfer line after the UCx target, resulting in a very clean beam. An important step towards higher precision was the first measurement of doubly charged ions, since the mass resolving power is linear in the charge of the ions. Another project started in 2005 was the implementation of a tape station above ISOLTRAP for decay spectroscopy with isobarically or even isomerically purified samples.

During 2005 the low-energy ion cooler and buncher project for high-quality radioactive beams progressed well with financial aid from the UK organization EPSRC. At the end of 2005 all the necessary hardware for the commissioning test had been received and the first tests were scheduled for January 2006. In 2005 a new control system was implemented for RF-devices and all power supplies. The developed control structure turned out to be relatively fast and reliable. Thus, some of the new features will be transferred to the general control system at the ISOLDE facility.

In 2005 researchers from Jyväskylä participated in the charge breeding studies at ISOLDE employing the Electron Cyclotron Resonance (ECR) ionization principle. Charge breeding of rare exotic isotopes, often extracted as singly charged ions, is of importance for cost-effective post acceleration both in the present REX-ISOLDE facility as well as in future RIB facilities such as EURISOL.

Technology Programme

The HIP Technology Programme continues to contribute to various EU funded Grid initiatives, and will have a greater responsibility for managing their Grid security activities. The Programme has further developed tools for CMS physicists to transfer large amounts of physics data across clusters over the Internet. The Programme has initiated close collaboration with CSC, the Finnish IT center for science, to better serve different scientific communities with their increasing computing and storage requirements. The collaboration with Finnish industry has intensified through detailed projects between CERN's Grid initiatives and Finnish IT-security companies. LHC@home, a volunteer computing initiative in which the Programme's researchers have been heavily contributors, has attracted well over 20,000 users offering Teraflops of free computing power to CERN's accelerator physicists. The Programme has moved to new premises at Innopoli2 in Finland.



Theory Programme

Kari Enqvist,
Theory Programme director,
Cosmology project leader

The Theory Programme provides a platform for the project leaders to conduct high-profile research in a few selected subject fields. The projects are fixed term with a default duration of 3+3 years. They are chosen on the basis of their scientific merits and complement the research in experimental physics at the Institute, as well as research at the host universities. The project leaders are expected to be able to secure considerable external funding for their projects; in fact all the present project leaders get their salaries from sources external to HIP. In 2005 there were five projects: Cosmology; Particle Physics Phenomenology; Physics of Biological Systems; String Theory and Quantum Field Theory; and Ultrarelativistic Heavy Ion Collisions. Outside the projects, there is also research activity in hadron physics.

Cosmology

The physics of inflation with an emphasis on non-Gaussian perturbations has been the focus of several studies. Second order inflationary perturbations were considered in the case of hybrid-like inflaton models. The sources for the discrepancies in different approaches were sorted out and it was shown that the results for the amount of non-Gaussianity obtained by perturbing the Einstein equation to second order and the so-called separate universe approach are compatible. We have also studied two-field models with preheating and showed that there can be a considerable enhancement of non-Gaussianity sourced by the local terms generated through the coupled perturbations. We also demonstrated that string motivated inflation ending via tachyonic instability leaves a detectable imprint on the cosmic microwave background (CMB) radiation by virtue of the excitation of non-Gaussian gravitational fluctuations. In curvaton models, limits on non-Gaussianities were shown to depend strongly on the assumed form of the curvaton potential. The often quoted lower limit on the non-Gaussianity parameter is valid only if the curvaton has no self-interactions.

Cosmology in extended theories of gravity has been considered assuming the Palatini variational principle, for which the metric and connection are independent variables. The field equations are derived to linear order in perturbations about the homogeneous and isotropic but possibly spatially curved background. Evolution equations were derived for perturbations in a late universe filled with cold dark matter and accelerated by curvature corrections. Such corrections were found to induce effective pressure gradients which are problematical in the formation of large-scale structure. A phenomenological three parameter fluid description was used to study the effect of dark energy on the CMB radiation and matter power spectrum. In addition to the equation of state and the sound speed, a non-zero viscosity parameter for the fluid was allowed. It was found that anisotropic stress perturbations are generated in dark energy, a possibility which is not excluded by present day cosmological observations. Structure formation of imperfect fluid dark energy characterized by an evolving equation of state was also explored in unified models of dark energy with dark matter, such as the Chaplygin gas or the Cardassian expansion, with a shear perturbation included.

The theory of cosmological curvature perturbations was developed in a completely covariant formulation. This novel approach is fully non-perturbative and relies on a covector combining the gradients of the energy density and of the local number of e-folds. The result is a

non-linear generalization of the familiar linear uniform density perturbation with a simple conservation equation which is exact, fully non-linear and valid at all scales.

In collaboration with the Department of Physical Sciences, the Cosmology project continued to participate in the Finnish Planck Surveyor Consortium. We are active members in the CTP working group, the purpose of which is to establish ways to estimate the temperature and polarization spectra of CMB. This activity has centred on concrete issues in map making, in particular destriping (Hannu Kurki-Suonio, Torsti Poutanen, and Reijo Keskitalo, a student), which is a tool for removing different kinds of systematic effects in CMB experiments. The basic idea in destriping is to model the noise stream by a linear combination of simple arithmetic functions. We have further developed an improved destriping algorithm using a maximum-likelihood approach.

In 2005 there were 2 PhDs in Cosmology: Torsti Poutanen and Jussi Väliviita.

Particle Physics Phenomenology

In phenomenology, the focus has mainly been in Beyond the Standard Model theories, although Higgs detection has also been studied in the Standard Model framework.

At the Large Hadron Collider (LHC) Higgs boson production in association with two jets and an accompanying photon with large transverse momenta, by means of the WW fusion, has been found to have a large cross section in the Standard Model. After appropriate kinematical cuts a sizeable number of signal events can eventually be observed at the LHC. Supersymmetric models with grand unification can lead to nonuniversal boundary conditions for the gaugino masses at the unification scale. The neutralino properties have been studied in such a case, as well as the neutralino and chargino mass sum rules. At the LHC, the Higgs detection was investigated when on one hand heavy Higgs bosons decay to neutralinos and charginos, and on the other hand when heavy neutralinos decay to Higgs bosons and light neutralinos. It was found that the non-universality has indeed a large effect on detection possibilities.

The successful unification of gauge couplings in supersymmetric models can be retained even when all the scalars of the theory, except one fine-tuned light Higgs boson, lie far above the electroweak scale. This is the idea of split supersymmetry which solves some problems usual in the supersymmetric models, like the flavour problem. In a model with split supersymmetry, the possibility to have a fixed point for top Yukawa coupling was studied. It was found that requiring a fixed point strongly disfavours models with split supersymmetry.

Sneutrino-antisneutrino mixing occurs in supersymmetric models where neutrinos have nonzero Majorana masses. This can lead to the sneutrino decaying into a final state with a "wrong-sign charged lepton". This signal is free of any Standard Model background and the supersymmetric backgrounds are small. It has been shown that such a signal can be seen experimentally in the $e\gamma$ operation mode of a linear collider. Information on a particular combination of the neutrino masses and mixing angles can also be extracted through the observation of this signal.

Violation of CP-symmetry is one of the big mysteries in the Standard Model. A supersymmetric model where CP-symmetry and also the so-called R-parity are determined by the properties of the vacuum of the model has been explicitly constructed. With broken R-parity, neutrinos also have a tiny mass, as observed in experiments. In our model, both the constraints on the mass differences and mixing angles in the neutrino sector, as well as from electric dipole moments can be fulfilled. In the framework of supersymmetric models with non-minimal flavour violation, a model independent analysis of the supersymmetric contributions to the CP asymmetries in $B \to J/\psi K_S$, $B \to \phi K_S$, $B \to \eta' K_S$, and $b \to s\gamma$ decays has been performed based on a mass insertion approximation and including all relevant contributions. Correlations between the various CP asymmetries and correspond-

Katri Huitu, Particle Physics Phenomenology project leader

ing branching ratios have been analyzed. The QCD factorization method has been implemented in order to calculate the hadronic matrix elements of the relevant fermion operators in B meson decay amplitudes.

The effects of the polarizations in the radiative light meson (pion and kaon) and muon decays have been studied. Doubly differential distributions in terms of momenta and helicities of the final lepton and photon have been explicitly computed. The photon polarization asymmetry has been evaluated for the first time in these decays. A possible test using photon polarization to clarify a recently observed discrepancy in the radiative pion decay is proposed.

The effects of the non-minimal supersymmetric extensions of the Standard Model in the neutralino-nucleon cross section which is relevant for the present Dark Matter detectors have been studied. In this analysis the most updated constraints on SUSY particle spectra, flavour changing neutral current constraints, such as $b \to s\gamma$ and B(d)-anti-B(d) mixing, $B \to \mu^+\mu^-$ decays, and recent measurements on the anomalous magnetic moment of the muon, as well as vacuum stability bounds, have been taken into account.

Hadron Physics Activity. By application of quark model rescaling factors to several realistic nucleon-nucleon interaction models, it was shown that double charm hyperons are likely to form deuteron-like bound states with nucleons. The corresponding states with beauty hyperons are likely to be deeply bound.

A systematic study of all $uuds\bar{s}$ positive parity configurations with one orbitally excited constituent revealed that the experimental observation that the strangeness magnetic moment of the proton is positive demands that the strange antiquark has to be in the ground state, and the *uuds* system has to be orbitally excited. The result indicates that $K\Lambda$ fluctuations of the proton are suppressed.

A complete canonical quantization of the SU(3) version of Skyrme's topological soliton model for the baryons was carried out for representations of arbitrary dimension. It was found that the Wess-Zumino-Witten term vanishes in all self-adjoint representations in the collective coordinate method for separation of space and time variables.

The polarizabilities of the neutral pion have been evaluated to two loops in chiral perturbation theory. The corresponding calculation of the charged pions is on the way.

The work on a pion-nucleon phase shift analysis with fixed-t constraints has continued. Lattice work on heavy-light systems has been extended to include dynamical fermions.

Physics of Biological Systems

The activities of the Biological Physics and Soft Matter (BIO) group focus on the theory and computational modelling of biologically relevant soft-matter systems. This work is guided by the idea of combining the methods and ideas of statistical physics with novel computational techniques to deal with topical problems of complex soft-matter systems.

The BIO group was initiated at the Laboratory of Physics (Helsinki University of Technology/HUT) in January 2001 and it joined the Theory Programme of the Helsinki Institute of Physics (HIP) (www.hip.fi) in January 2002. Consequently, the BIO group operates jointly at HUT and as part of HIP.

The BIO group is part of various networks, including SIMU (ESF), MOLSIMU (COST), FuncDyn (ESF), and the NORDITA network on biological physics. In 2005, the group published 17 articles in international high-quality journals, 5 articles are in press, and several under review. The BIO group is also part of the Computational Condensed Matter and Complex Materials Group (COMP) at the Laboratory of Physics in HUT, which in 2005 was selected as a Centre of Excellence by the Academy of Finland for 2006–2011. Further, the group is an associate member of the MEMPHYS biophysics group in Odense, Denmark, which is a Centre of Excellence chosen by the Danish Research Council.

The positive activities and the unconventional crossing of scientific boundaries, or the ability to take research risks, were possibly the main reason

why the Academy of Finland granted the BIO group the 2005 Incentive Award.

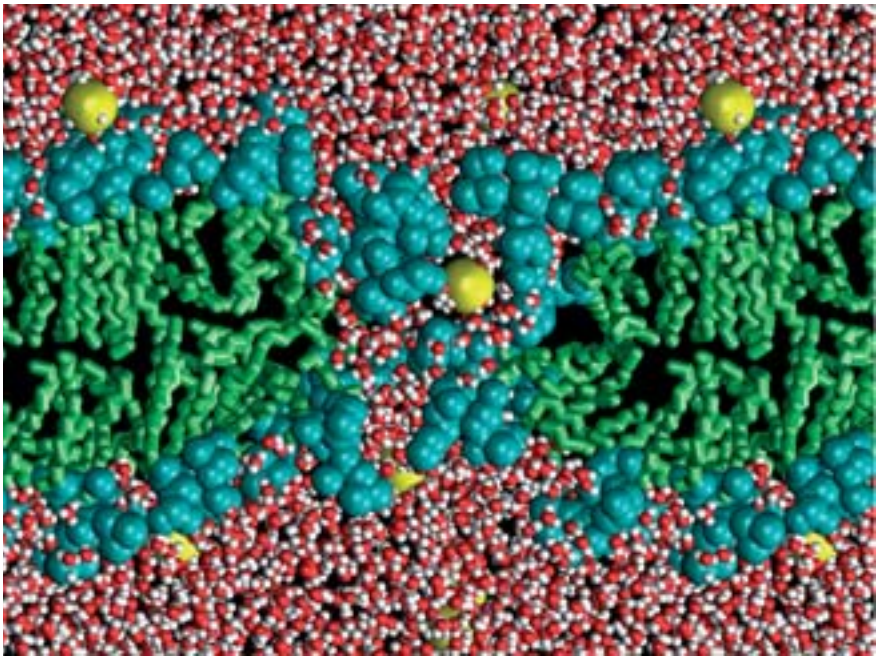
Overall, the activities of the BIO group are comprehensive and it has a wide range of both theoretical and experimental collaborative partners whose fields range from medical sciences to chemistry, physics, and computational sciences. In particular, there is a very close and highly active collaboration with Dr. Mikko Karttunen's group at the Laboratory of Computational Engineering (HUT). The two groups have created a team of roughly 20 people working on the same campus and focusing on a wide range of issues related to biologically relevant soft-matter systems. In December 2003, the team was selected as a Helsinki University of Technology Young Center of Excellence for 2004–2005.

The research of the BIO group consists of three main themes that complement each other. First, we develop novel techniques for studies of soft matter. Second, we apply these methods to characterize the atomic-scale properties of biomolecular systems. Third, we employ multi-scale modelling to gain insight into the large-scale properties of given systems. Below, we present a few examples of related recent projects.

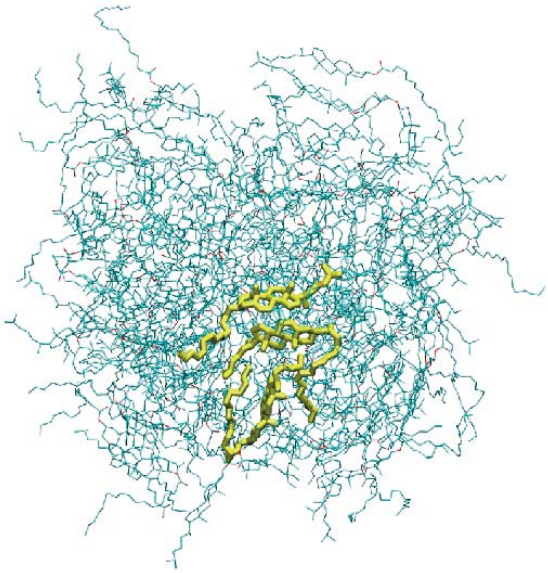
The development of new theoretical and modelling techniques is an essential part of our work since biological systems are highly complex and characterized by a multitude of different length and time scales. This fact implies that nanoscale studies of biological phenomena must be complemented by mesoscale as well as macroscale (continuum) investigations of related phenomena. In practice, this calls for novel attempts to design coarse grained models for large-scale studies of biosystems. We have used the "bottom-up" approach, where the objective is to first develop coarse-graining techniques, and second to apply them to simplify atomistic descriptions of soft-matter systems in a systematic fashion. The systematic nature of coarse graining means that the effective intermolecular interactions used in the coarse grained model are systematically derived from detailed atomic-scale MD simulations or experimental data using, e.g., the Inverse Monte Carlo technique. When this approach is coupled to novel mesoscale simulation techniques, it provides a means to consider large-scale properties of soft matter while preserving a bridge to the underlying microscopic world.

In the atomistic limit, we have considered a variety of different systems comprised of proteins, lipids, and DNA. The aim is to understand the mechanisms that govern the structure and dynamics of these systems using both analytical and computational techniques. As for lipid membranes, we have examined many-component lipid bilayers composed of various saturated and polyunsaturated glycerophospholipids (PC's), sphingomyelin, and cholesterol. These lipid rafts, as they are commonly called, have been suggested to play an important role in a variety of cellular processes such as signal transduction and protein sorting. Additionally, we have investigated the properties of lipid bilayer mixtures of PC's and cationic lipids commonly used in non-viral techniques for gene delivery, and clarified the influence of salt on these systems. Closely coupled to experiments, we have further addressed questions related to the structure of lipoproteins and the interplay of drugs such as antibiotics with lipid membranes, and the influence of small molecules such as alcohols on membrane systems.

Ilpo Vattulainen, Physics of Biological Systems project leader



Formation of a transient water pore in a lipid membrane due to a salt ion gradient across the membrane. The pore facilitates ion leakage thus perturbing ATP synthesis and the maintenance of osmotic balance, among others. (Courtesy Andrei Gurtovenko, HUT.)



A mixture of cholesteryl ester molecules found inside lipoproteins used as carriers of cholesterol. (Courtesy of Mikko Heikelä, HUT.)

The third theme of the BIO group deals with large-scale properties of soft-matter systems. On the one hand, this work involves the development of multi-scale modelling and coarse-graining techniques. On the other hand, the above-discussed techniques are applied to complex biomolecular systems. Most recently, the research has focused on structural transitions in DNA and the theoretical issues related to polyelectrolytes. Additionally, we have used the Inverse Monte Carlo approach discussed above to coarse grain and model lipid membrane systems comprised of saturated glycerophospholipid and cholesterol molecules, and initiated work to extend this approach to lipid rafts. This approach provides a speed-up of approximately seven orders of magnitude compared to atomistic simulations.

Esko Keski-Vakkuri, String Theory and Quantum Field Theory project leader

String Theory and Quantum Field Theory

This group investigates frontier topics in String Theory and Quantum Field Theory, the main theoretical framework of High Energy Physics and Astroparticle Cosmology.

In String Theory, our activities have been focused on viewing it as a quantum theory of gravity. In particular, recent work has been motivated by potential applications in Cosmology. For example, there has been much activity in developing new cosmological scenarios (e.g., string-based mechanisms for inflation) based on the properties of brane decay.

However, brane decay is a complicated process with many yet ill-understood or unknown properties. As an example, we studied amplitudes for string scattering off decaying branes. This is a very challenging mathematical problem in general, and there is a need to develop useful mathematical techniques for calculations. We have shown that generic n-point amplitudes for tree level scattering amplitudes can be cast in the language of random matrices, where they turn out to involve series of Toeplitz determinants depending on a single periodic function that encodes the data about the scattering process.

As another application of brane decay, we investigated a model for a Big Bang -like initial singularity. Perhaps the most challenging problem in Quantum Gravity is the question of whether initial conditions can be formulated in a physically meaningful way at the Big Bang. We proposed a novel scenario where all the energy in the Universe is stored in an unstable brane prepared at the initial singularity. The energy is then released into closed string radiation in the subsequent decay of the brane. However, the set-up allows for a dual description in the language of open strings, with no singularity so that the process has a regular description. This work (in collaboration with a team at the University of Illinois at Urbana-Champaign) was published and featured on the front cover in Physical Review Letters.

The year 2005 also included other work still in progress: (i) We investigated the fate of D-branes wrapping some manifold when its volume goes to zero, in theories with minimal supersymmetry in four dimensions. We showed that generically the branes become unstable and decay to some stable but non-supersymmetric D-branes. The branes have an interesting geo-

metric interpretation at non-zero volume. (Work in collaboration with IOP and IACS, India). (ii) As an example of quantum geometry, we studied the solutions describing quantum fluctuations about a two dimensional anti-de Sitter space, and found the quantum mechanical description for this process. (iii) We investigated strings as probes of the interior of a black hole, and found that contrary to common lore associated with the "no-hair theorem" of black holes, stringy objects could reside inside a black hole as hair.

In Quantum Field Theory, the group has continued its study of noncommutative (NC) space-time, investigating its space-time symmetries. In this direction the group has made a breakthrough by showing that, although NC QFT's violate the Lorentz invariance in the usual sense, they have a twisted Poincaré symmetry, whose generators are the same as the usual Poincaré generators. Therefore, the particles in NC space-time are classified, just like in commutative space-time, according to their mass and spin. This new symmetry gives justification to all the previous treatments and calculations, such as perturbative unitarity, UV/IR mixing, NC instantons and relation to matrix models, made in the literature in a formally Lorentz invariant form in spite of its violation. This work led to a publication in Physical Review Letters.

Such a symmetry, in addition, leads to a new concept of relativistic invariance defined for the noncommutative space-time, which has been explored in the formulation and proof of the analogue of Haag's theorem in QFT. Based on this symmetry, the group has further obtained the exact results of QFT, i.e., the dispersion relations, CPT and spin-statistics theorems and the Froissart bound on the high energy growth of the total cross section, also in the case of NC space-time, using the developed axiomatic formulation of such theories. The group has also continued the study of model building in the noncommutative context, proposing a gauge-invariant and anomaly-free noncommutative version of the Standard Model. The group also works on higher-dimensional theories and grand unification.

Another direction of research in the group has been the problem of confinement based on BRST symmetry and its consequences. Along this line an interesting connection between colour confinement and massive gluons has been found.

Ultrarelativistic Heavy Ion Collisions

Kari J. Eskola, Ultrarelativistic Heavy Ion Collisions project leader

The studies of QCD matter and its phases, quark-gluon plasma (QGP) and hadron gas, form a subfield of particle and nuclear physics with an active interplay between experimental and theoretical research. Since summer 2000 the RHIC collider at Brookhaven has generated an impressive amount of high-quality data from ultrarelativistic heavy ion collisions (URHIC), revealing QGP signatures such as very high energy densities, significant collective flow, suppression of large-p_T hadrons and disappearance of away-side jets. Even more exciting possibilities will be offered by the ALICE experiment at the CERN-LHC, operating from 2007 onwards. The URHIC project in the HIP Theory Programme started in 2002 and is now on its second three-year term. We are located at the Department of Physics, University of Jyväskylä, and at HIP and the Department of Physical Sciences, University of Helsinki. We focus (1) on URHIC phenomenology by making calculations for observables measurable at BNL-RHIC and CERN-LHC/ALICE, and (2) on studying the properties of QCD matter through first-principle calculations. We participate actively in international conferences and workshops, European graduate schools and EU networks. The year 2005 was particularly successful for us in that three PhD students graduated from our research groups.

Among our specialities is the computation of initial densities of the QGP produced in A+A collisions. In a closed framework based on perturbative QCD (pQCD), collinear factorization and gluon saturation, we have computed these densities, including net-quark number, for A+A collisions at RHIC and in particular

at the LHC, and used them as initial conditions in describing the space-time evolution of the produced system by hydrodynamics. An approach complementary to the pQCD + saturation model is the lattice evaluation of the classical Yang-Mills equations of motion of the gluon fields. We have developed a method to calculate quark-antiquark production from the classical gluon fields. Results both for the 1+1 and full 1+3 dimensional cases have been obtained. Remarkably, the outcome suggests a very fast fermion and antifermion production. This in turn makes rapid chemical equilibration possible. We have also shed new light on the complicated problem of parton thermalization: our studies of real-time evolution of plasma instabilities in anisotropic QGP using a hard-loop effective theory suggest a rapid isotropization rather than a slower one typical at a weak coupling limit. *(Collaboration with Saclay, BNL, Frankfurt, Wien, Bielefeld.)*

Our activities in URHIC phenomenology have involved various studies of hadron spectra. In the pQCD + saturation + hydrodynamics approach we have shown that the bulk of small-p_T spectra and multiplicities of identified hadrons at RHIC are correctly reproduced with a single, high, decoupling temperature $T_{dec} \sim 150$ MeV. Based on these RHIC-tested results, we have published predictions for the p_T-spectra of hadrons in central Pb+Pb collisions at the LHC. On the other hand, we have computed the large-p_T hadron spectra by folding together collinearly factorized pQCD cross sections, fragmentation functions, nuclear parton distribution functions (nPDFs) and energy losses of energetic partons in the QGP. Determining the amount of parton energy loss in the QGP at RHIC, we predict the pattern of large-p_T hadron suppression at the LHC. A comparison with the hydrodynamic spectra suggests that hydrodynamics can be applied in a wider p_T-range at the LHC than at RHIC. We have also initiated studies on supersonic Mach cones around partonic jets at RHIC, currently one of the most exciting new phenomena possible at RHIC. Also, we have actively investigated the azimuthally asymmetric spectra in non-central collisions, which we have shown to be sensitive to the QCD matter equation of state. Publishing predictions for the production of electromagnetic probes at the LHC and studies on the dynamics of the decoupling process are on our to-do list, as well as a fully 3+1 dimensional hydro code. *(Collaboration with CERN/TH, Duke, Frankfurt.)*

We have made more progress in our pQCD studies of nPDFs needed in the computation of collinearly factorizable hard processes in nuclear collisions. A global DGLAP analysis of the nPDFs, similar to that for the free proton, is ready to be published. In considering further constraints for the nPDFs, we have shown that the anomalously large value of the weak mixing angle measured in deep inelastic neutrino+Fe and antineutrino+Fe collisions in Fermilab,

the NuTeV anomaly, could well be explained by having mutually different modifications of valence u and d quark distributions in iron. *(Collaboration with CERN/TH.)*

An ongoing grand project has been the determination of the sixth order non-perturbative term in the perturbative expansion of the free energy of hot QGP. This plasma is remarkable in that its perturbative expansion, which due to asymptotic freedom could be expected to be very accurate at very high temperature, at sixth order actually contains a non-perturbative term. Like any other particle mass, it can only be computed numerically. We have during the previous years formulated a precise set-up for determining this coefficient and performed several required intermediate steps. We have now performed the required entirely numerical step. What remains is one extremely demanding but feasible analytic computation to be done with techniques of symbolic computation. This is under way but it may take years. Similar high-precision analytic methods have also been applied to the study of the thermodynamics of electroweak matter. *(Collaboration with CERN/TH and Bielefeld.)*

We have continued to investigate various effective theories to better understand the phase transition dynamics in QCD and QCD-like theories. We are currently studying the interplay between chiral and diquark condensates in a Polyakov loop background. Exporting our knowledge of strong interactions to the Higgs sector of the Standard Model, we have constructed new Technicolor models and showed that these are not ruled out by the current precision measurements, they do not suffer from problems with flavour-changing neutral currents and can accomodate a light Higgs particle. *(Collaboration with Frankfurt, NBI, BNL.)*

High Energy Physics Programme

Heimo Saarikko,
High Energy Physics
Programme director

In 2005 the activities of the High Energy Physics Programme, supported also by the Department of Physical Sciences / Division of High Energy Physics (SEFO) and the Academy of Finland, consisted of the following main activities: Final stages of the physics analysis based on LEP-DELPHI e^+e^- data sets were completed. During 2005, the focus of the electron-positron physics was redirected to R&D work for a future collider, the Compact LInear Collider (CLIC). In the CDF experiment at Fermilab, the activity concentrated on the analysis of experimental data delivered by the Tevatron accelerator, and focused especially on top-quark mass investigations. The group has key positions in preparing the physics programme of the TOTEM experiment at the forthcoming LHC collider at CERN, and is responsible for constructing and testing the TOTEM T2 tracking stations. In the Detector Laboratory, large projects supporting Finnish participation in research programmes at CERN, as well as generic detector development continued. Educational programmes embedded into research activities have played a central role: the research and experimentation activities at CERN and Fermilab constitute a platform for educating and training students in physics and technology. The group has been active also in outreach efforts.

Kenneth
Österberg,
Electron-
Positron
Physics project
leader

Electron – Positron Physics

During 2005, the focus of the project was redirected from completing the physics analysis of the data from CERN's previous collider, the Large Electron Positron (LEP) collider, to R&D work for a future collider, the Compact LInear Collider (CLIC). The accelerator R&D related to the development of suitable accelerating structures for CLIC is done within CERN's "CLIC accelerated R&D" programme, in close collaboration with the CERN CLIC group, the Technical Research Centre of Finland (VTT) and Finnish industrial partners. The aim of the R&D programme is to demonstrate the feasibility of the proposed CLIC-technology in view of a decision on a future linear collider in 2010. In autumn 2005, a memorandum-of-understanding (MOU) on the Finnish contribution to the R&D programme was signed between HIP and CERN.

The technological challenges for the material in the accelerating structures for CLIC are two-fold: limiting the RF breakdown and increasing the tolerance to pulsed surface heating. The most promising candidate is bi-metallic structures with refractory metals (e.g., Mo) in the high electric field regions (i.e., the irises) and copper alloys (e.g., CuZr) in the rest of the structure, where most of the heat is dissipated, other solutions are also being pursued. The group's CERN-based micromachining expert, Jukka Paro, is surveying different machining methods for several candidate materials as well as organizing the survey of the machined prototypes for the CLIC accelerating structure development team. In fact, Finnish industry has shown considerable interest in this development and a significant fraction of these prototypes are made by Finnish firms. Our group is also following up tests of several methods for making a sufficiently solid bond between the two metals in bi-metallic structures. The produced test structures will undergo intensive testing at CERN and the aim is to produce several complete accelerating structures to be tested at the CTF3 test facility at CERN in conditions as close as possible to those of CLIC itself. The goal of the whole structure technology development programme is to be able to find the most optimal solution in terms of performance, production and cost.

Concluding more than two decades of Finnish activity at LEP, the last two physics analyses by the Helsinki group, based on the data taken by the DELPHI experiment during

1989–2000, were accepted for publication in the European Physical Journal in 2005 and the last Finnish PhD thesis (Laura Salmi's) using the DELPHI data is expected to be defended in spring 2006. Related to strong interaction physics, the group found support for the existence of Bose-Einstein correlations between identical bosons produced from the two different W's in $e^+e^- \rightarrow W^+W^-$ in the DELPHI data. Related to electroweak physics, the group measured the statistical moments of the lepton energy spectra in semileptonic B decays to determine the value of B decay model parameters. This leads, combined with other similar measurements, to a significant improvement in the accuracy in the determination of the quark mixing matrix element $|V_{cb}|$.

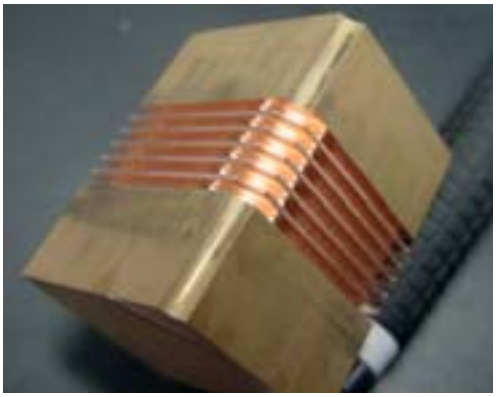
Forward Physics at Tevatron and LHC

In the CDF experiment at Fermilab, the group concentrates on the analysis of experimental data delivered by the Tevatron accelerator and is currently measuring the mass of the top quark in semileptonic and all hadronic decay channels and is partly responsible for the daily operations of the silicon vertex detector and for off-line tracking performance studies. The CDF experiment has a dual role: It is currently the only data taking Particle Physics experiment with Finnish participation and attains the highest available centre of mass energy, making it a unique laboratory for studying the properties of the top quark. In addition, it serves as a training ground for young experimentalists in the field, preparing them for realistic data-taking conditions and analysis techniques applicable to the LHC, which will start operations at the end of 2007.

The Helsinki group has firmly established its physics analysis activities within the CDF experiment at Fermilab's Tevatron collider in 2005. This is complemented by the operational maintenance and off-line quality control of the Silicon Vertex detector. The Tevatron collider's performance exceeded expectations in the past year and delivered over 1 fb^{-1} of integrated luminosity to each of the experiments, with peak luminosities exceeding 10^{32} $cm^{-2}s^{-1}$. As a result, the top quark physics output has been tremendously boosted and 15 papers on the subject were submitted for publication this year. Tuula Mäki is working on her PhD thesis on top quark mass measurement in the di-lepton decay channel using a Monte Carlo template method and lepton kinematics. Her results have been presented at various international conferences and workshops and will be submitted for publication in early 2006. The CDF combined top mass in the di-lepton channel amounts to 170.1 ± 6.0 (stat.) ± 4.1 (syst.) GeV/c^2. Tuula is permanently based at Fermilab and she is also part of the Silicon Vertex expert team at CDF. The top quark mass measurement in the all hadronic decay channel was initiated by the Helsinki group in May 2004 by Ari Kiiskinen, Nick van Remortel and Petteri Mehtälä. Petteri Mehtälä completed his MSc thesis on the subject in June 2005 with a grade of Laudatur and he is continuing the analysis for his PhD work. The measurement, based on the *ideogram* technique, originally developed in the DELPHI experiment is now established and recognized within the CDF experiment and will be submitted to winter conferences in 2006. The analysis group was complemented by Timo Aaltonen of the University of Helsinki, who started his MSc thesis in September 2005.

The off-line studies of the Silicon Vertex detector data of CDF, performed at the Kumpula Campus, have been focusing on the implementation and tuning of fast and realistic charge deposition models, based on GEANT. Matti Kalliokoski of the University of Helsinki joined these activities in June 2005 where he started his MSc thesis on the implementation and tuning of the parametrized charge deposition model of the innermost layer of the Silicon Vertex detector, the so-called Layer00.

The fruitful collaboration with the Rovaniemi Polytechnical Institute (RAMK) was continued with the projects of three Rovaniemi summer students sent to Fermilab where they contributed to the Silicon Vertex on-line data quality monitoring tools.



A machining test done as part of the CLIC accelerating structure R&D. The machining test shown in the figure was done by one of our industrial partners in the Finnish CLIC R&D network.

Risto Orava, LHC Forward Physics project leader

The TOTEM experiment was conceived to cover elastic scattering, total cross section and diffraction dissociation at the LHC as stated in the Letter of Intent (LoI) submitted to the LHC on 15th August 1997. Since the initial LoI, the experiment and its goals have been specified further in the Technical Design Report of 7th January 2004. It is understood that TOTEM constitutes *the* experiment of forward physics at the LHC. This experiment will, together with the CMS, cover more phase space than any other detector installation at a hadron collider.

The physics scenario of TOTEM is based on (1) short special high statistics runs which begin during the running-in stages of the machine, and (2) forward physics runs in conjunction with the CMS experiment with the nominal low-β^* machine conditions. The TOTEM collaboration focuses on physics that is *complementary* to the general purpose experiments at the LHC, and therefore has had to invest heavily in designing, developing and testing instrumentation that will be capable of meeting the challenge of recording data in the very forward region. After seven years of effort, the baseline TOTEM experiment has been configured as described in the TOTEM TDR and comprises Roman Pot detectors for the leading proton measurement, and the two tracking stations (T1 and T2) in the forward region of the CMS.

In addition to developing the special detector techniques required, the TOTEM collaboration has extensively analyzed the physics reach of its forward physics installation. As discussed in the TOTEM TDR and in TOTEM presentations to the LHCC, the physics programme of the experiment consists of the following:

(1) *Elastic* proton-proton scattering, *total* proton-proton cross section, soft and hard diffraction. The proton structure can be investigated beyond the usual longitudinal parton density functions, and pure gluon jet analyses with large statistics will become available. The T2 tracker enables proton gluon densities to be measured down to a Bjorken-x of 10^{-6}, the dynamics of rapidity gap survival (including the phenomena behind the generation of multiple gaps) can be extended to rapidities of close to 7 units. Physics of the proton light cone could be studied in kinematical configurations that have not been available to *any previous* experiment. In addition, more detailed features of diffractive and small-x processes – such as jet, W, J/ψ, b- and t-quark production will be available to experimentation. Possible saturation effects of the parton densities, BFKL dynamics and multi-parton scattering could be investigated by the TOTEM experiment.

(2) With the leading proton tagging (with a possible later stage extension to the 420 meter region) and the T1 and T2 spectrometers, TOTEM could *threshold scan* for spin-parity selected new particle states, including the Higgs boson, SUSY particle states, radions, extra dimensions etc. The analysis foresees later stage low-β^* runs, and also the well-known Central Exclusive Diffractive interaction: $pp \rightarrow p + H + p$ which is considered as a benchmark process, with an *exclusive* access to the J^{PC} structure of the Higgs boson.

(3) In addition to the TOTEM physics programme, the experiment provides an extension to the kinematic reach of CMS, and enables luminosity independent accurate measurement and monitoring of the LHC luminosity. With its excellent forward acceptance, TOTEM could be of crucial help in studying the minimum bias events and in jet energy calibration of the CMS calorimeters.

The signatures of the TOTEM physics scenario include the leading proton, rapidity gap, inelastic activity (characteristics of the diffractive system, jets, identified particles etc.); for each one of these, the TOTEM experiment will provide rapidity and azimuthal coverage that crucially complements the reach of the CMS experiment in its baseline configuration. The forward physics road map of TOTEM relies on tagging the leading protons, identifying the rapidity gaps within a sufficiently large η range, and by rejecting the backgrounds by track and double-arm coincidence selection by the Roman Pots and T1 & T2 detector stations. All

these detector systems are built by the TOTEM collaboration and are based on several years of design, development and testing efforts by the TOTEM member institutions.

To reach the physics goals discussed above, it is fully realized that TOTEM has to be integrated in the trigger and data recording systems of the CMS experiment, and in case of the signatures depending on the central CMS detectors (e.g., the CED Higgs process), a common plan of utilization of the two experimental setups should be agreed on.

During 2005, the first level (L1) triggering criteria in combined CMS and TOTEM data taking was investigated in detail for central diffractive production of a 120 GeV Higgs decaying into two b-jets. This is rather challenging since the L1 bandwidth will already be saturated at luminosities of 10^{32} $cm^{-2}s^{-1}$ with a 2 central jet requirement, each having a transverse energy larger than 40 GeV, which is necessary to retain the signal. The study showed that combining central jets either with a proton seen by one of the closer-by Roman Pots or a high transverse momentum muon from semileptonic b-decays will allow the L1 rate to be kept at an acceptable level ($\sim$ 1 kHz) while still retaining a good efficiency for the signal for luminosities up to 2×10^{33} $cm^{-2}s^{-1}$.

The above study was a natural continuation of the group's work on demonstrating the full potential of new particle searches using the central exclusive diffractive channel, $pp \rightarrow p + X + p$. Previously the group has shown that the mass of the central system, X, can be reconstructed with a 1–2% precision using the protons only. The group extended the work on the leading proton acceptance during 2005 to include protons with arbitrary scattering angle and momentum loss. All of the studies mentioned above are published in the proceedings of the "HERA and the LHC"-workshop. In addition the group leader, Prof. Orava, co-chaired the workshop's diffractive session.

The physics analysis activities of the Helsinki group focus on acceptance and trigger studies for forward proton tagging, simulation of signatures for new physical phenomena, including the Higgs and particles beyond the Standard Model and physics of diffraction. Furthermore, an efficient trigger pattern based on the information from the T2 telescope of TOTEM has been devised by the group for the reconstruction of charged particles from the interaction point and thereby enabling efficient triggering of diffractive events at low-luminosity running of the LHC. This pattern will be refined once more accurate performance data on the Kumpula Detector Laboratory assembled T2 GEM-detectors with their proper LHC readout electronics is available.

The group is responsible for constructing and testing the T2 tracking stations of the TOTEM experiment and participates in the design of silicon sensors and mechanical structures (microstations) for forward proton tagging at the LHC. In 2005, the manufacturing and validation of the Gas Electron Multiplier based TOTEM T2 detectors in Helsinki was launched. Altogether 50 triple-GEM's will be constructed at the Detector Laboratory in Kumpula. Based on this project, the Helsinki group has gained the position of a leading detector group in GEM-based technologies.

In addition to its responsibilities in manufacturing the TOTEM T2 spectrometer and preparing the TOTEM trigger scenarios, the Helsinki group has key positions in preparing the physics programme of the TOTEM experiment and in establishing search strategies for the Higgs boson in the CED processes detected by the 420 m leading proton detectors.

Detector Laboratory

Two large projects continued to exploit the Detector Laboratory premises during 2005. The Silicon Strip Detector (SSD) module assembly project for the ALICE experiment operated with full production speed throughout the year, occupying the largest part of the clean rooms. Altogether, 525 SSD modules have been assembled by the end of 2005 corresponding to 2.5 million individual single-point TAB interconnections. In addition, the Gas Electron

Markku Oinonen, Detector Laboratory coordinator

Multiplier (GEM) development and assembly project has been ramped up for the TOTEM experiment and the production is up to start. On the other hand, the CMS project finished its carbon-fibre rod assembly for the SSD detectors during summer 2005, but continued to prepare a FinnCRack test bench for the assembled SSD rods. In order to improve the visibility of the Laboratory, in May 2005 a new website was established for the Detector Laboratory, which contains descriptions of the active projects.

Since the preparations for LHC at CERN will start to be finalized in 2006, the Laboratory has started to investigate possible future projects to concentrate on. One possibility under discussion is to continue the GEM or SSD manufacturing for the PANDA experiment, under preparation within the FAIR upgrade of GSI, Darmstadt. The PANDA collaboration has warmly welcomed the possible participation. The participation would pave the way for a future linear accelerator project by also keeping the Laboratory's expertise up-to-date over the next few years.

Production of the TOTEM T2 GEM detectors in the clean room.

A fast thermal cycling chamber purchased within the Academy of Finland Infrastructure programme during late 2004, was taken into full use during 2005. This equipment with temperature (-70°C–+150°C) and humidity control (10–90% RH) allows for versatile temperature and humidity dependent studies of any kind of object. During 2005, most of the time was used for lifetime acceleration studies of ALICE SSD components and also for projects from the Electronics Research Unit of the University of Helsinki.

The Laboratory has had a close working relationship with the Electronics Research Unit (ERU). Collaborations included studies of non-destructive quality control techniques for ultrasonic bonds and investigations of the ultrasonic bond process in general. These studies aim to strengthen the position of the Detector Laboratory as a world-class ultrasonic bonding laboratory.

The group uses the *Detector Laboratory* for developing, manufacturing and testing novel gaseous and silicon based sensors, readout systems and data acquisition modules for future experiments in High Energy Physics, fusion diagnostics and space research. In 2005, the detector development activity concentrated on building facilities and working procedures for the production of TOTEM-T2 GEM detectors. New devices and instruments were installed in the clean room to fulfil the requirements for a high-quality production line. Almost all the manufacturing phases were planned to be carried out in the clean room, half of which is currently used by the group. Only the very first cleaning phase and the final operation tests will be done elsewhere in the Laboratory.

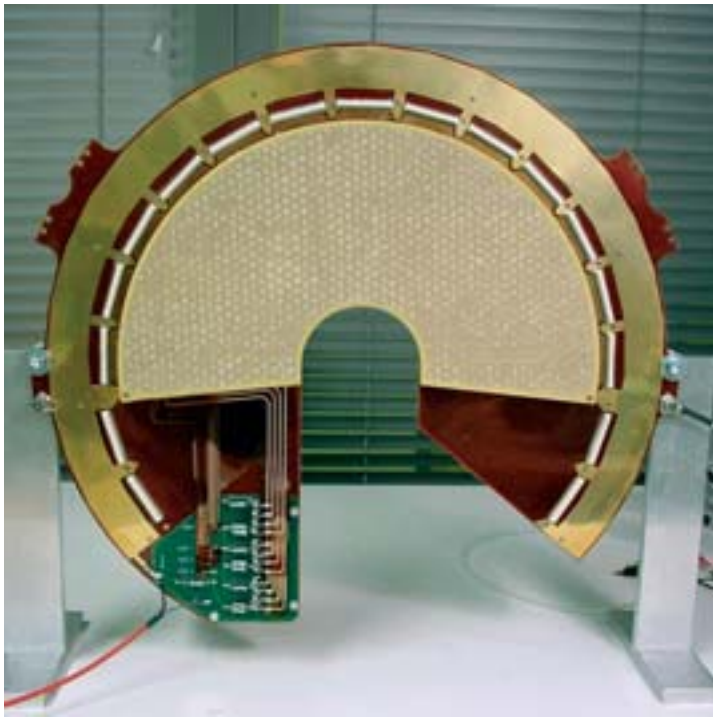
The production of the T2 GEM's started during the second half of the year by assembling two GEM's according to the final design. In addition, two prototypes were previously manufactured according to the first design. New test procedures for the quality checking of the detector component were developed as well. These include, e.g., a method of scanning GEM foils and a semi-automatic capacitance measurement of the readout board.

Educational programmes

The research and experimentation activities at CERN and Fermilab constitute a platform for educating and training students in physics and technology. The Detector Laboratory also serves as the basis of education and training in experimental High Energy Physics. The group members are responsible for basically all the graduate level university education of high energy experimentalists in Finland. The PhD candidates of the group presently include students from the University of Helsinki, Helsinki University of Technology, the University of Heidelberg and ETH Zurich. In 2005 these activities involved 13 PhD students, several MSc students, participation in the European Union Research Training Network, and in the beginning stages of an EU funded detector development program (EUDET). The group is supported by the Academy of Finland.

In addition, the group has established summer student and technical training programmes at CERN and Fermilab in connection with its own research projects. The Helsinki group is one of the eleven members – and the Finnish co-ordinator – of a European Union Research Training Network (RTN) "New generation of quarks as a probe for new physics". The RTN brings together a number of leading European research groups working in the field of heavy quark physics at CERN and Fermilab. The group collaborates with a number of Finnish Polytechnical Institutes and has established R&D and training programmes with the Polytechnics in Kuopio and Rovaniemi.

The group was involved in organizing a national event for the "European MasterClasses for High School Students: Hands on Particle Physics" 7.–19.3.2005. This event was part of the World Year of Physics 2005 (WYP 2005) activities, and was arranged jointly in 60 European university departments from 18 countries. In Finland, altogether 36 students from five different schools participated in this event, and more than 2,000 in the whole of Europe. The programme of the MasterClasses event included high-standard lectures in Modern Physics, visits and experimental work in local laboratories, as well as a common European video conference, where the results of the experiments were collected and experiences of the day exchanged with participants in other European universities.



The first TOTEM T2 GEM detector assembled in Helsinki.

CMS Programme

Jorma Tuominiemi,
CMS Programme director

The HIP CMS Programme carries the responsibility for the Finnish participation in the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider (LHC). The CMS experiment is designed to study proton-proton collisions at 14 TeV collision energy and heavy ion collisions at the LHC. Its main scientific goal is the clarification of the main open questions in High Energy Particle Physics today: the mechanism of the spontaneous breaking of the electroweak symmetry (the existence of Higgs bosons), the existence of supersymmetric particles, and the existence of quark gluon plasma. In addition, there are new fundamental questions that are gaining increasing interest, like the study of the existence of extra dimensions in the Universe. The CMS detector concept was first proposed in 1990, and the Finnish team has played an important role in its development from the beginning. The HIP CMS team hence has an extensive and thorough knowledge of the key features of the experiment. With the CMS experiment HIP will be in the frontline of High Energy Physics research to take the next fundamentally important step in understanding the basic structure of matter and the origin of the Universe. The LHC experiments are scheduled to begin in 2007. In 2005 all the parts of the CMS detector system were under construction and the time schedule for its installation in the experimental cave had been consolidated. Problems in the delivery of the components of the central Tracker were solved. Preparation for the physics analysis was being completed with the publication of the first volume of the Physics Design Report, based on a massive Monte Carlo simulation of events and testing of the CMS trigger selection and reconstruction software. HIP is actively involved in both of these activities. The HIP CMS Programme is divided into two projects: 1) the CMS Software and Physics project, whose goal is to develop simulation and analysis software for the CMS experiment and to evaluate the discovery potential of the CMS detector design for new physics, 2) the CMS Tracker project that carries responsibilities in the design, construction and testing of the central tracking detector. Both projects are running an active educational programme for PhD and undergraduate students.

Veikko Karimäki,
CMS Software
and Physics
project leader

CMS Software and Physics

General

The HIP software team has been participating in the CMS project since the beginning of the 1990's, when it was initiated. The team is involved in the CMS software and computing effort, which has been estimated to require a total of about 700 person years by the time of the fulfillment of the major milestones by 2006. The main emphasis of the HIP team is on the simulation, calibration and event reconstruction for the CMS Tracking system. In computing the team is contributing to the data intensive GRID project which involves massive Monte Carlo production of simulated LHC events in close collaboration with other CMS institutes in Europe and the USA, using GRID tools. The team continues to work on the challenging calibration problem of detector alignment with the goal to prepare effective software tools for precise determination of the detector module positions by using reconstructed tracks. Other contributions by the HIP team are in the fields of detector simulation with the objective to develop the event reconstruction software and in physics simulation with the goal to check the discovery potential of the CMS experiment. The team is also responsible for the on-line and off-line software of the Helsinki Silicon Beam Telescope and participates in the analysis of the CMS Cosmic Rack data.

The CMS Software and Physics group organized "The 2nd Finnish Geant4 Workshop" with 24 participants. The members of the group act as a Local Organization Committee for the CERN School of Computing which will take place in August-September 2006 at the Kumpula Campus.

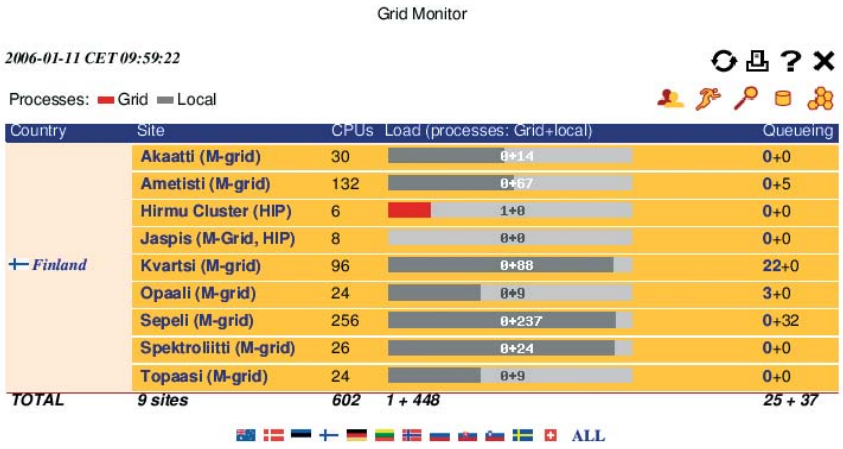
Computing activities

HIP CMS computing resources. HIP jointly operates the 64-CPU 32-bit mill Linux cluster with the Department of Physical Sciences and the 132-CPU 64-bit ametisti Linux cluster with the Departments of Chemistry and Physical Sciences. Two Linux clusters with nine nodes in total, testbed0 and testbed1, are used for testing and development. The HIP CMS Programme also runs two Linux fileservers, silo and silo2.

Linux clusters. The NPACI Rocks Cluster Distribution operating system on the testbed0 cluster was upgraded from the Red Hat 7.3 based Rocks 3.0.0 (Lhotse) version to the Red Hat Enterprise Linux (RHEL) based Rocks 3.3.0 (Makalu) version to ensure compability with the RHEL based Scientific Linux Cern 3.x distribution and to prepare for the corresponding upgrade on mill. The batch queue system on testbed0 was upgraded by the HIP Technology Programme to the Sun Grid Engine (SGE) release 6 update 6 also in preparation for the mill upgrade to decrease the differences between the mill and ametisti clusters. The standard CMS programs were installed and validated with the installation tool xcmsi, which demonstrated the compability between Rocks 3.3.0 and SLC 3.0.x. On mill the latest version of Geant4 was available in addition to the standard CMS programs installed with xcmsi on the silo2 fileserver. The operating system on the mill front-end was upgraded from Rocks 3.0.0 (Lhotse) to the Rocks 3.3.0 (Makalu) version. On ametisti Geant4 and Root were installed. Test configuration of the Parallell Root Analysis Facility (PROOF) was also set up. The xcmsi installation on ametisti still needs more work.

Disk servers. Funding for disk upgrades on the silo2 fileserver were possible through two grants from the Magnus Ehrnrooth Foundation. By using part of a TOTEM/CMS shared grant and part of a grant to the HIP Technology Programme enough funds were available to order disks to fill up all remaining sixteen disk slots on silo2, which increases the capacity of silo2 from 1.5 TB to 7.5 TB. An Opteron server to be used as a dCache/xrootd server was also ordered with the funds available. It will be used to ascertain if the local disk space on the ametisti nodes can be utilized to create a distributed filesystem.

Grid computing. HIP participates in the NorduGrid project, which has produced the NorduGrid Advanced Resource Connector (ARC) middleware used on the M-grid clusters and on most clusters run by HIP. HIP also participates in the Large Hadron Collider Computing Grid (LCG) project, which is a pilot project for the Enabling Grids in E-sciencE (EGEE) project and the Nordic Data Grid Facility (NDGF). The HIP Software group members represented Finland and HIP in various grid- and computing meetings and workshops. Grid middleware on mill and testbed0 has been administered together with the Technology Programme and on ametisti with CSC. After CSC had implemented support for SGE in ARC and the 64-bit issues with ARC had been solved all 64-bit M-grid clusters including ametisti could be connected to the largest Grid in Finland. When CSC's new sepeli cluster joined M-grid this effectively created the largest (distributed) computing resource in Finland. This was pointed out in a joint M-grid



Ametisti is a part of M-grid, which has grown into the most powerful distributed computing system in Finland.

CSC press release in December. The disks on the silo2 fileserver were filled up with simulated data from CMS Data Challenge 04 by using a set of home made scripts using the GridFTP-protocol and published for local usage on mill using CMS validation scripts. The CMS reliable file transfer tool PhEDEx was installed on the 1.4 TB fileserver silo by the HIP Technology Programme to significantly simplify the transfer of large data sets from the CERN CASTOR tape archive and other CMS sites.

Monte Carlo production. The HIP Software team continued its participation in the CMS Monte Carlo Production activities. A major task of CMS during 2005 was to demonstrate the data transfer capabilites between the CERN Tier-0 and the major Tier-1 centres and some Tier-2 centres during the Service Challenge 3. CMS continued analysis of the simulated data samples from 2004 in addition to generating new samples for analysis in preparation for writing the Physics Technical Design Report (TDR).

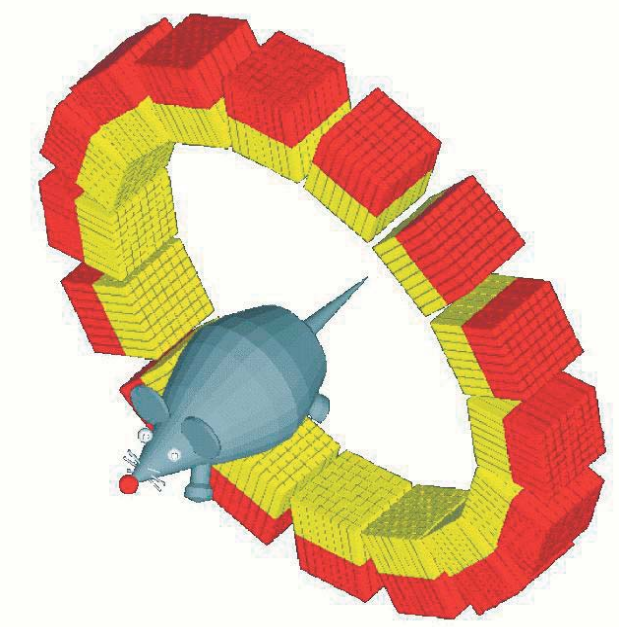
Geant4 development and physics generators

GEANT4 development. The major new achievement by the HIP team in 2005 was the contribution to the Geant4 release 8.0 with the improved Bertini hadronic cascade model. The model was improved by including incident kaons and lambdas in the particle-nucleus processes. Another contribution to the release 8.0 was to include for the first time a HIP made modelling of hadronic elastic scattering.

Bertini cascade models are among the most important options available for the simulation of hadron-nuclear interactions in the general detector simulation toolkit Geant4. Hadronic models in Geant4 toolkit are now extensively used to produce physics results from various particle physics production runs. Detailed validation of Geant4 is still in progress. After favorable reports from the LHC Computing Grid simulation physics validation project, the Bertini models are now used in LHC background radiation studies. In comparison with Geant3 the Bertini model provides significantly better scattering cross sections for incident pions.

The comparison of Geant4 hadronic performance with experimental data is focusing on the validation of isotope production. Typical users for this kind of physics modelling are experiments studying underground cosmic background. In many cases the performance of Geant4 Bertini cascade, with fission and fragmentation models, is comparable to classic codes such as CEM, LAHET or CASCADE. In June the CMS Software and Physics group organized "The 2nd Finnish Geant4 Workshop" with 24 participants.

Physics generators. The HIP team continued maintaining and developing the package CMKIN which provides physics events for the detector simulation. By the end of 2005 almost 20 different physics generators were optionally available in CMKIN, to mention maybe the most important ones: PYTHIA, Isajet and Herwig. In addition interfaced with CMKIN are a number of 'external generators' like TopReX, AlpGen and MadGraph, which work in the PYTHIA context. Recently some important generators for the simulation of LHC background processes have been implemented like cosmic and beam halo particles as well as beam-gas interactions.



Geant4 is a showcase example of technology transfer from particle physics to other fields such as medical imaging. Simulation of a small PET scanner using Geant4. (Courtesy of the OpenGate Collaboration.)

Calibration and event reconstruction

Alignment calibration. An important mission of the HIP Software and Physics project is to develop software for the calibration of the sensor positions in the CMS Pixel and Strip tracking detectors based on silicon technology. This calibration task, called detector alignment, is based on reconstructed tracks and aims at finding corrections to sensor positions and orientations so that the optimal trajectory reconstruction is obtained. The group has the responsibility to develop alignment methods and strategies especially for the Pixel detector.

The HIP team participated actively in the alignment activities of the CMS Tracker by implementing the first working alignment algorithm for the CERN TOB Cosmic Rack. Successful alignment was carried out with test beam data. This small-scale proof-of-principle shows that successful alignment can be carried out with genuine CMS hardware and reconstruction software. The first simulation studies for the Pixel detector were also carried out.

The group was also involved in the task of implementing ready-made misalignment scenarios for the CMS tracking devices. These scenarios can be used in more realistic physics studies in the future.

The analysis of the geometric precision measurements of the rod frames of the CMS Tracker support structure was finalized in collaboration with the HIP Tracker project. The analysis served as well as quality assurance for the approval of the precision gluing of the sensor supports and pins as calibration measurements for the final detector module positions.

The team also finalized the off-line analysis of the beam tests of the HIP Silicon Beam Telescope made in summer 2004. An extensive analysis of these data was performed by the team in order to investigate the performance of heavily irradiated Czochralski type silicon detectors.

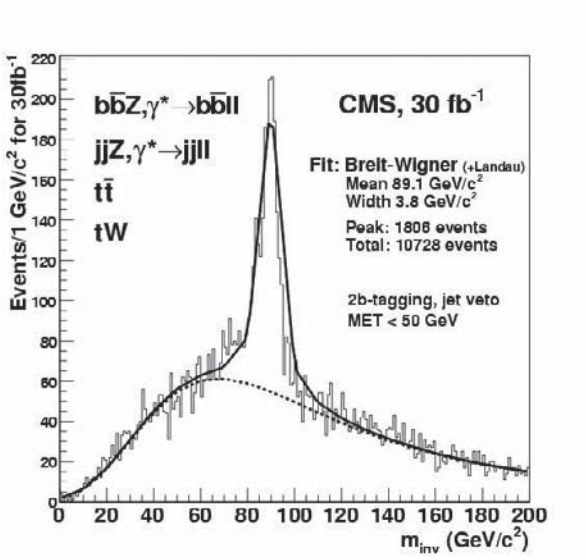
Event reconstruction. In 2005, our team has continued their activities in the software development for the electron and photon reconstruction. We have developed tools for photon reconstruction, and they are described in Volume I of the CMS Physics Technical Design Report, summarizing the reconstruction methods which will be used in the data analysis.

A major item has been the implementation of the photon object in the reconstruction software. The precision of the photon energy measurement is crucial for an early discovery of the $H \rightarrow \gamma\gamma$ signal at the LHC, and our team has implemented a tool to estimate the quality of the energy measurement. This estimate is provided by parameterizing the energy resolution as a function of different factors: the photon energy, the shape of electromagnetic shower, the local energy containment in the cluster and the split of the energy on different sides of the crack between the active ECAL areas. The uncertainty estimate provides a tool that can be used in the event selection. Selecting the photons with a small uncertainty in $H \rightarrow \gamma\gamma$ reconstruction gives the category of events with the best mass resolution.

Furthermore, we have been active in the test beam analysis where effort has been put into measuring the position dependence of the energy containment in the calorimeter. Energy containment is an important quantity to be understood for calibration of the calorimeter in order to be able to retrieve the correct energy of clusters in different parts of the calorimeter. The test beam analysis also offers a possibility to verify the simulation algorithms used at CMS by comparison with real data.

Physics analysis

The preparation of the Physics Technical Design Report (pTDR) continued intensively during 2005. The HIP group has taken the responsibility to develop the τ - tagging methods with vertex reconstruction and with impact parameter tagging and to analyse three of the major discovery channels of the MSSM Higgs bosons, the $H/A \rightarrow \tau\tau$ decay channel with two-lepton and electron+jet final states and the $H^{\pm} \rightarrow \tau\nu$ decay channel with fully hadronic final states in the region of $m_{H^{\pm}} > m_{top}$. In addition, the



Reconstructed Z → ll invariant mass in the bbZ production channel in the CMS detector.

Eija Tuominen, CMS Tracker project leader

group is participating and leading the simulation of the H → μμ decay channel of the SM Higgs boson with the Chandigarh group. The group members have worked as referees for publications and CMS analysis notes.

The simulation work included reconstruction of large event samples for the signal and the backgrounds, development of the analysis methods and presentation of the results. The reconstruction was performed mainly with the GRID based ASAP tool.

Tagging of the hadronic τ decay with impact parameter and vertex measurement was studied. The measurements were found to be sensitive to the track building algorithm due to collimation of tracks and long propagation distances in the forward direction, which gave valuable information for developing the tracking algorithms. The tagging was shown to be usable despite the problems.

Development of the methods for τ identification, b tagging, missing transverse momentum measurement, top quark reconstruction and Higgs boson mass reconstruction were continued for the H/A → ττ and $H^{\pm}$ → τν channels. Methods based on the quality of the track measurement were developed to suppress the fake τ background from hadronic jets in the τ identification. To improve the precision of the mass reconstruction in the H/A → ττ channels a new method of missing energy reconstruction was introduced.

The associated Z production pp → bb̄Z+X was studied as a benchmark for the associated Higgs production pp → bb̄H+X. The two production mechanisms are topologically similar providing an opportunity to study the Higgs production mechanism with Z bosons. The Z signal, extracted from the background, is shown in the figure to the left. The bb̄Z events can be used to measure the associated b quark and Z boson transverse momentum distributions from data to verify the Monte Carlo predictions.

Outreach activities

The HIP CMS Programme and the High Energy Physics Division of the Department of Physical Sciences together with the Physical Society in Finland made a high energy physics poster in Swedish describing LHC, ALICE, CMS and TOTEM experiments for a Swedish school teacher seminar on Innovations and Creativity in Natural Sciences held in Arcada during 10-11 February 2005. The HIP CMS Programme contributed to the Finnish national Physics Day programme at the Kumpula Campus with two high energy physics posters and by playing nonstop CERN and CMS related videos in auditorium E207 in Physicum on 8 October 2005.

CMS Tracker

In 2005, the HIP CMS Tracker Project concentrated its efforts on three main activities: 1) completion of the ten-year sub-project "design and construction of the mechanical support structure for the CMS Tracker Outer Barrel (TOB)", 2) construction and operation of the Finnish Cosmic Rack (FinnCRack), a telescope based on silicon detectors measuring tracks of cosmic particles and designed to test the CMS TOB detector systems as well as new detectors for future upgrades, 3) development of radiation hard silicon detectors for future high intensity particle physics experiments.

Tracker Outer Barrel Mechanics

The CMS Mechanics team successfully completed the design and construction of the high-precision, lightweight support structures, "rods" for the

CMS TOB detectors. Construction covered assembly work of the rod frames and their quality assurance. During 2005, the rod assembly work was completed at the Physicum Laboratories in Kumpula. A total of 750 rod frames were manufactured, tested and delivered to CERN. Rod frames underwent a thermal shock treatment of -30°C in a deep-freezer. Visual inspection followed to study flaws etc. After the thermal cycle, performance of each rod frame cooling system was measured. In addition, the quality assurance included the measurement of functional physical dimensions of the assembled rod frames. Geometrical measurements took place at the Laboratory of Machine Design of the Helsinki University of Technology. After the completion of the rod production at Kumpula, HIP technicians moved to CERN in order to perform TOB integration with other CMS groups.

Another activity of the Mechanics team was the design and manufacture of the housings for the CMS Resistive Plate Chamber (RPC) Link Boards. The housings provide means for the precise Link Board attachment/detachment. They meet the strict space and maintenance constraints of CMS, and provide practical service routings. Well-engineered thermal management ensures low temperatures at the component level. At the beginning of 2005, a total of 12 Link Board housings were delivered to CERN and mounted on the noses of the CMS end-caps. Tapio Laihomäki completed his diploma work about the electrical housings and graduated from the Helsinki University of Technology, Department of Mechanical Engineering.

HIP technicians Auli Kuronen, Pauli Engström and Jarmo Kortesmaa assembling CMS Tracker Outer Barrel (TOB) detector rods with Antti Onnela from CERN (second left) and with Erkki Anttila from HIP (second right).

Finnish Cosmic Rack (FinnCRack)

FinnCRack is a telescope based on silicon strip detectors that measures tracks of cosmic particles. It is constructed using components of the CMS Tracker Outer Barrel (TOB) mimicking a six degree (in azimuth) slice of the TOB barrel structure. It will be used as a test station providing real data for testing of the TOB subsystem level functionality as well as for development of TOB software, e.g., analysis software (ORCA), software alignment code, online software, and run control software. It also plays an important role in the testing of the novel radiation hard detector concepts for the CMS upgrade and for future experiments. Erkki Anttila completed his diploma work about the mechanics of FinnCRack and graduated from the Tampere University of Technology, Department of Mechanical Engineering.

During the summer 2005, FinnCRack containing four CMS detector rods, was made operational at CERN. The first tracks of cosmic particles were measured and reported. The procedure to transport FinnCRack to the HIP Detector Laboratory in Kumpula was initiated. It is waiting for the delivery of the final baseline CMS readout electronics, which is late in schedule. Co-operation with the students and teachers from the Rovaniemi Polytechnic Institute (RAMK) has had an important role in the development of FinnCRack.

The Tracker project has also participated in the design, development and production of special power supplies with highly improved non-standard specifications to test and cal-

HIP researchers testing Tracker Outer Barrel (TOB) rods with the Finnish Cosmic Muon Rack (FinnCRack).

ibrate silicon detectors and their front-end electronics. These power supplies form an essential part of the FinnCRack. Additionally, some 60 power supplies have been distributed to different CMS Tracker groups developing and testing Tracker detector systems and electronics.

Silicon Detector Development

In the future high energy physics experiments, radiation hardness will be the major limitation for the use of silicon sensors. For example, the proposed upgrade of the CERN LHC luminosity up to 10^{35} $cm^{-2}s^{-1}$ is expected to take place in 2015. However, the first upgrades and detector replacements of the LHC experiments are foreseen already in 2010. The HIP CMS Tracker project is participating in the international research on radiation hard silicon detectors in the frameworks of the CMS Upgrade programme and of CERN RD39 (60 members, 19 institutes) and RD50 (280 members, 55 institutes) research programmes. The contributions of the HIP CMS R&D team in RD50 were recognized by the choice of the venue of the 6th RD50 Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders, this was hosted by the Helsinki Institute of Physics in Physicum at the Kumpula Campus on 2–4 June 2005. In addition, Dr. Jaakko Härkönen continued as a spokesperson for the RD39 programme.

Proposed detector solutions aiming to match the challenging requirements of radiation tolerance include detectors made of high resistivity magnetic Czochralski silicon (MCz), n-on-p sensors made of p-type MCz, epi detectors,

Participants of the 6th RD50 Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders in front of the Physicum building.

charge injected detectors (CID), 3D detectors and cryogenic operation of silicon sensors. The pioneering research of the HIP CMS R&D team on the radiation hardness of Czochralski silicon detectors has gained outstanding interest in the international research community. In 2005, we reported the first ever test beam results of a proton irradiated full-size Czochralski silicon (Cz-Si) particle detector, also processed by our group. Proton irradiations were carried out at the Accelerator Laboratory of the University of Jyväskylä and the test beam experiment was done at the CERN H2 beam using the HIP Silicon Beam Telescope (SiBT). Additionally in 2005, our group together with the CERN RD39 Collaboration launched a project to build Transient Current Technique (TCT) and Charge Collection Efficiency (CCE) set-ups at CERN. These set-ups have the unique feature that they can be operated in the temperature range from 2 K to 300 K. The first data obtained from the LHe-TCT (Liquid Helium TCT) set-up was taken in December 2005.

The HIP CMS R&D team processes detectors at the Helsinki University of Technology Microelectronics Centre where the HIP Tracker project is a member. The electrical characterizations are done using an upgraded measurement set-up at the clean room facilities of HIP and the Department of Physical Sciences of the University of Helsinki in Kumpula. In 2005, we also started a joint research activity with the Helsinki University Accelerator Laboratory and with the Helsinki University of Technology Physics Laboratory to study defect mechanisms of silicon detectors with Positron Annihilation Spectroscopy.

Nuclear Matter Programme

Juha Äystö,
Nuclear Matter
Programme director

The Nuclear Matter Programme provides full participation of the Finnish teams at CERN in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with extreme composition of its proton and neutron numbers and hot and dense matter created in relativistic heavy ion collisions. The first project is carried out at the ISOLDE Facility and the second one concentrates on the construction of certain parts of the ALICE detector for the LHC machine as well as on the relevant physics issues. The ISOLDE project has its physics motivation in studies of exotic structures of nuclei, with a special emphasis on weak interaction phenomena and nuclear astrophysics. The ALICE project aims to study the phase transitions of hadronic matter and possible signatures for a new form of matter, the quark and gluon plasma. The project leaders of these two projects are Docent Ari Jokinen for ISOLDE and Dr. Markku Oinonen for ALICE. In addition, the Nuclear Matter Programme has co-ordinated the Finnish participation in the planning of the FAIR project at GSI. FAIR stands for the international Facility for Antiproton and Ion Research.

Markku Oinonen,
ALICE project
leader

ALICE

The construction period for the ALICE experiment has become even more intense during the year 2005 on the eve of ALICE's start-up. The Finnish ALICE team has been successfully involved in assembling the tracker components, design and construction of the T0 detector and development of the track reconstruction software. The growing importance of physics and data analysis in the work of our group has been strengthened by the creation of a new research position at the University of Jyväskylä, paid jointly by HIP and JYFL, and Dr. Jan Rak has stepped in to take that position at the end of 2005. Furthermore, since the data analysis and physics emerging from it will form the basis of continuing future activities, preparations for the computational infrastructure have been launched on several fronts. This includes involvement in the national initiative towards a GRID infrastructure in Finland, involvement in the plans for the Nordic ALICE computing infrastructure and usage of the existing resources.

Physics and tracking

Analysis of the observed hadron spectra and correlations at RHIC reveal three transverse momentum ranges with distinct behaviours: a soft range $p_T \leq 1.5$ containing the remnants of the bulk collision, an intermediate range $1.5 \leq p_T \leq 6$ where hard processes compete with the soft ones, and a hard-scattering range $p_T \geq 6$ providing partonic probes of the early stage of collision matter. At RHIC, the statements for observing deconfinement of nuclear matter and creation of a Quark Gluon Plasma (QGP) have been formed by exercising extreme caution in the absence of strong direct evidence. Recent theoretical studies by Rafelski suggest that at LHC energies, strangeness may be further enhanced relative to RHIC given that at the LHC we reach greater initial temperatures and more explosive flow. Within the emerging picture the question of strange quark production in hot QCD is far from being settled and experimental cross-checks that require high statistics and precision data in a larger p_T range are needed to fully explore the

observed phenomena and their connection to properties of dense matter.

Kaons, being the lightest strange hadrons are expected to dominate the strange sector by virtue of canonical thermodynamics. With a significant kaon production at LHC energies, owing to the high branching ratio of kaons to the muonic decay channel and to the large angular acceptance of the central barrel of ALICE, the reconstruction of the kink topology is a key technique for identifying kaons over a momentum range much wider than the one achieved by combining PID signals from different detectors. During the last year the Jyväskylä team has finalized the reconstruction algorithm and the physics analysis required to extract the expected yields of reconstructed kaon decays at the LHC. The results have been published in Vol. II of ALICE's Physics Performance Report.

T0 fast timing and trigger detector

The T0 detector (chief responsibility of the Jyväskylä team) has to work from Day 1 of ALICE's data acquisition. Without a fully operational T0, data taking will not be possible at all. The T0 performance has a direct impact on vertex determination, Time of Flight (TOF) results, operation of the Transition Radiation Detector, V0 monitoring, and data normalization. T0 together with V0 will play a dominant role already in extracting the so-called Day One Physics, this involves measurements of the pseudorapidity density $dN/d\eta$, p_T spectra, multiplicity distributions, dependence of mean transverse momentum on multiplicity etc.

Due to the highly restricted space in the central region of ALICE, the acceptance of T0 is very limited. It has a total of only 24 detector modules. At the same time both the complexity and cost per channel (module) is by far the highest of all the ALICE sub-detectors. In 2005 all of the key construction parameters were finally frozen. In May 2005 T0 electronics underwent a comprehensive review by a panel of independent experts appointed by LHCC. The reviewers had no major objections to the electronics scheme and were impressed by the 28 ps time resolution reached for the amount of light corresponding to 1 MIP. In June 2005, T0 completed the Production Readiness Review receiving a green light for the production of all detector modules. The final construction has now considerably less material. It resulted in cutting the radiation length in half as compared to the first carbon fibre prototype. The next major milestone was crossed in November 2005 with the successful completion of the full chain electronics readout: the super-fast front-end electronics of T0 and readout electronics of the TOF detector were combined. As a result, the 28 ps resolution for 1 MIP was reproduced and 13.6 ps resolution for 30 MIP signals from the calibration laser was reached.

An important issue for ALICE Forward Detectors is radiation hardness. In August 2005 a series of irradiations were carried out at JYFL with a 60 MeV proton beam. The irradiated components included all the key elements of the V0 detector and the T0 front-end electronics. The irradiations had a progressively increasing duration (from 20 to 2,000 seconds). Each irradiation was followed by thorough tests of the investigated components. The tested T0 electronics worked perfectly for the first 5,000 seconds. After a total of about 7,000 seconds of irradiation (90 krad/cm^2) a 2% drop in both the +6 V and -6 V low voltage power supply current was observed that however did not affect the amplification gain. After 9,000 seconds of operation (112 krad/cm^2) the unit was damaged (flat 2V on the output). The +6V current increased by a factor of 2 and the -6V current drain was down by a factor of 2. This test has shown that the dose sufficient to kill the front-end electronics is of the order of 100 krad/cm^2. The dose of 100 krad/cm^2 is the expected integrated dose over a 10 year operation period of ALICE. Although 10 years of ALICE operations might be reached with the present electronics chain we are investigating several options to solve this possible problem. The easiest would be to prepare for periodic replacements of the sensitive components.

Ari Jokinen, ISOLDE project leader

ALICE/ITS/SSD module assembly

The two largest layers of the ALICE Inner Tracking System (layers 5 & 6) will contain 1698 Silicon Strip Detector (SSD) modules. The production of these modules is shared between France, Italy and Finland. The assembly of the Finnish share of SSD modules (defined by so-called core funding) is being done in the HIP Detector Laboratory (DL) in Helsinki in tight collaboration with 19 researchers from Kharkov and Kiev while the quality control of the SSD assemblies is being taken care of by the local group. The strong Ukrainian participation is motivated by the fact that all the interconnecting Al-polyimide cables in the SSD modules are manufactured in the Ukraine. These low-Z replacements of standard Cu cables contribute a major technological breakthrough leading to significant reduction of the radiation length of the non-active volume in the central region of ALICE.

Extensive life-time acceleration studies for the components were performed throughout the year. If made correctly the spTAB interconnections will not fail during the expected ALICE operational lifetime of 10–15 years. Since the Helsinki Laboratory has been pioneering the bond process development and the SSD assembly within the collaboration, a paper based mainly on the Helsinki experience on the ALICE SSD assembly was presented at the LECC'05 Conference in Heidelberg in September. Within the quality control of the SSD assemblies a new non-destructive method for accessing the ultrasonic bond quality has been proposed. It uses a Scanning White-Light Interferometer to measure the height of the bond. It has been proved that this non-destructive height measurement instead of a destructive bond pull test can be used to ensure the high quality of a bond. These studies form an essential part of Henri Seppänen's thesis and the technique has the potential to become a useful inspection method for microelectronics in general.

Up to the end of 2005 a total of 530 SSD modules have been assembled in Helsinki containing over 0.8 million channels and 2.5 million individual single-point TAB (spTAB) interconnections. This makes the project the largest detector module assembly enterprise ever conducted in the history of Finnish science. The mass production phase will continue until the spring of 2006 and the resources will be then adjusted towards the maintenance and operation phase of the ALICE ITS. Due to excellent working conditions established in the Detector Laboratory, an assembly step of electrically insulating the so-called ladder cables for reading out the SSD signals was launched in Helsinki at the end of 2005.

ISOLDE

Solid state physics

Diffusion studies employing the modified radiotracer technique were continued with ^{52}Mn and ^{54}Mn implantation at ISOLDE in GaAs and $Si_{1-x}Ge_x$ alloys. Inclusion of magnetic impurities such as Mn at high concentrations in semiconductors offers good prospects for combining magnetic phenomena with high speed electronics and optoelectronics. However, there are no relevant diffusion data for Mn and the related diffusion mechanisms are still unclear. The aim of the experiments was therefore twofold: i) to provide quantitative data for Mn diffusion in GaAs and SiGe at low Mn concentrations, ii) to reveal the effect of the material growth technique on GaAs diffusion properties by verifying the role of excess Ga vacancies in the diffusion process. In addition off-line implantation of radioactive ^{7}Be ions to Ge, $Si_{1-x}Ge_x$, glassy carbon and several metals was carried out, this is partly related to the ion source development work done at ISOLDE.

Advanced timing measurements on Mg isotopes

In our studies of light neutron-rich nuclei we have examined excited states in heavy Mg isotopes close to the "island of inversion" by applying advanced timing techniques. With this

method it is possible to obtain complementary information on transition strengths, which to date have only been extracted from Coulomb excitation (Coulex) measurements with radioactive ion beams. Coulex data obtained in different laboratories (GANIL, MSU, RIKEN, and CERN) are in disagreement and thus a complementary method had been requested. The first experiment concentrating on the lifetime determination was performed as early as 2004. In 2005 the experiment was continued with an improved set-up and by applying for the first time conversion electron measurement to search for E0-transitions. The analysis of the 2005 data is continuing.

Precision mass measurements at ISOLTRAP

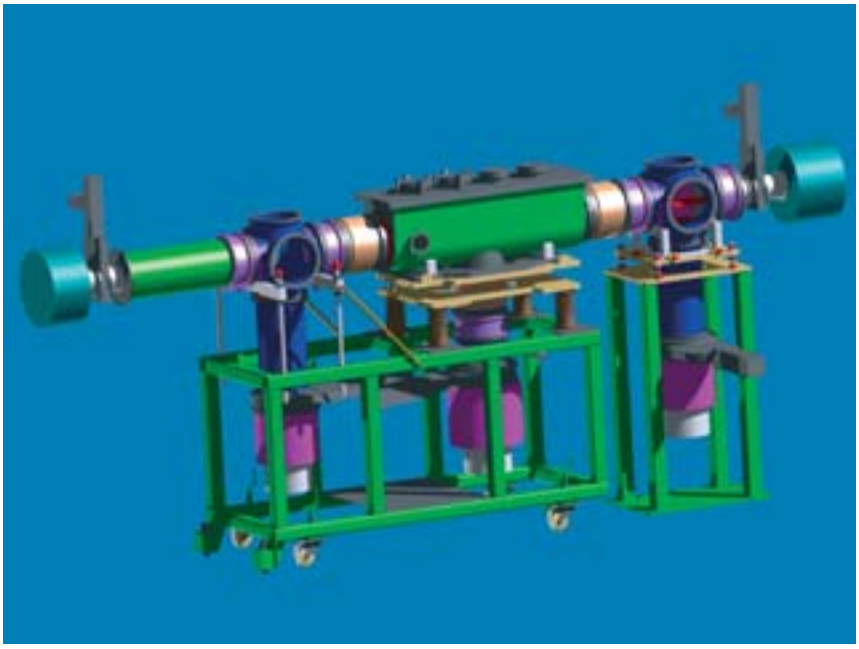
Collaboration with the ISOLTRAP group continued in 2005. Ulrike Hager spent 6 months at CERN and participated in several experiments and projects at the ISOLTRAP facility. One of the experiments was devoted to measuring the masses of neutron-rich ^{71}Zn to ^{81}Zn isotopes with a high precision. An important factor in the success of this experiment was the good beam quality from ISOLDE due to a new quartz transfer line after the UCx target, resulting in a very clean beam. Unfortunately, this new technique could not be employed in the measurement of Cd isotopes. However, it was still possible to measure ^{120}Cd, ^{122}Cd and ^{124}Cd.

An important step towards higher precision was the first measurement of doubly charged ions, since the mass resolving power is linear in the charge of the ions. The stability of the precision trap could be improved considerably in 2005 by implementing a pressure and temperature stabilization system for the magnet. Another project started in 2005 was the implementation of a tape station above ISOLTRAP for decay spectroscopy with isobarically or even isomerically purified samples. Simulations were conducted using the SIMION ion-optical simulation program in order to explore the possibility of focusing the ion beam to a narrow tape, while at the same time retaining the possibility to insert the channeltron into the beam line. Based on these results the design of the tape station set-up was begun, taking into account the very limited space available above the traps.

Beam preparation research and development

During the year 2005 the ion cooler and buncher project progressed well with financial aid from the UK organization EPSRC, this allowed full investment in the missing components and electronics. At the end of 2005 all the necessary hardware for the commissioning test had been received and the first tests were scheduled for January 2006. In 2005 a new control system was implemented for RF-devices and all power supplies. The developed control structure turned out to be relatively fast and reliable. Thus, some of the new features will be transferred to the general control system at the ISOLDE facility.

In 2005 researchers from JYFL participated in the charge breeding studies at ISOLDE. Charge breeding of rare exotic isotopes, often extracted as singly charged ions, is of importance for cost-effective post acceleration both in the present REX-ISOLDE facility as well as in future RIB facilities such as EURISOL.



An artist's view of the beamline section with a new ion cooler and buncher (ISCOOL). ISCOOL is installed in the vacuum chamber (green section) between two ceramic insulators. The whole assembly is supported by a trailer system allowing an easy intallation and removal of the new device.

Technology Programme

Ari-Pekka Hameri,
Technology Programme
director

During 2005, the HIP Technology Programme continued to contribute to numerous international Grid activities. The focus of the research and development work remained on Grid security both in the CERN-orchestrated Enabling Grids in E-SciencE (EGEE) and in the industrial NETwork identity, Grid service Access and Telecom Enabled provisioning (NETGATE) projects. The industrial outreach effort was rewarded with CERN OpenLab contributor agreements for two leading Finnish IT-security companies, both partners of the NETGATE project consortium. In addition the cluster activities around the Finnish Material Sciences Grid (M-Grid) reached an important collaboration agreement with CSC, the Finnish IT center for science. LHC Physics-related activities continued the deployment of Grid-enabled software in Finland and the co-ordination of CERN OpenLab initiated the LHC@home project. Two PhD students worked on an Academy of Finland funded Grid for Scientists research project. The year was also marked with a move from the old Ekono building to the modern Innopoli2 building in Otaniemi, Espoo.

Miika Tuisku,
DataGrid project
leader

Security work in European Grid projects

The EGEE project has established itself as the flagship project among European commission funded Grid projects in 2005. The mission of the EGEE project is to provide the European Research Area with a 24/7 Grid facility by connecting scientific computing centres around Europe. The large impact of the project became evident through the establishment of a dozen smaller satellite projects and support actions around the EGEE. Subsequently, EGEE secured European community funding for the years 2006-2008 with a two-year follow-up project called EGEE-II. The Finnish contribution to the project will be doubled as CSC joins with HIP in the consortium, this will make a total of almost hundred partners. HIP continues to be the national contact point for the EGEE project and remains a board member in the Northern European Grid (NEG) federation.

Despite the fact that EGEE is spread out in numerous federations throughout Europe, CERN remains the competence centre in the project. The presence of the HIP Technology Programme at CERN helped to increase its responsibilities in the EGEE Security activities (JRA3). HIP participants in EGEE functioned as CERN security cluster leaders. Furthermore Dr. White from HIP was invited to act as a deputy leader of the Joint Research Activities (JRA1) that combines data management, monitoring, security and testing work packages. EGEE is thus already preparing for the new organizational model that will be introduced in April 2006 with the launch of EGEE-II.

In 2005, HIP provided Grid with the transport layer with security software for java web services, Grid credential delegation software as well as supported virtual organization membership services (VOMS) application development together with JRA1 partners. Furthermore HIP co-authored two important deliverables describing Secure Credential Storage and Grid Accounting System. Parts of the results were also presented at different conferences.

Cluster activities and the Nordic Grid Facility

The HIP Technology Programme has studied and developed cluster computing in practice by operating and maintaining two clusters in Otaniemi: a small Linux cluster funded by the

Magnus Ehrnrooth Foundation (Hirmu) and a modern 64-bit Linux cluster (Jaspis) installed in 2005 as a part of the M-Grid. Grid middleware and a batch scheduling system were deployed on the Jaspis Cluster making it available to all M-grid users. Both clusters are also connected to NorduGrid. The Finnish offices of the Technology Programme moved to Innopoli2 this year. As part of the move the network infrastructure was updated. The connection to Funet was upgraded to 1 Gigabit per second.

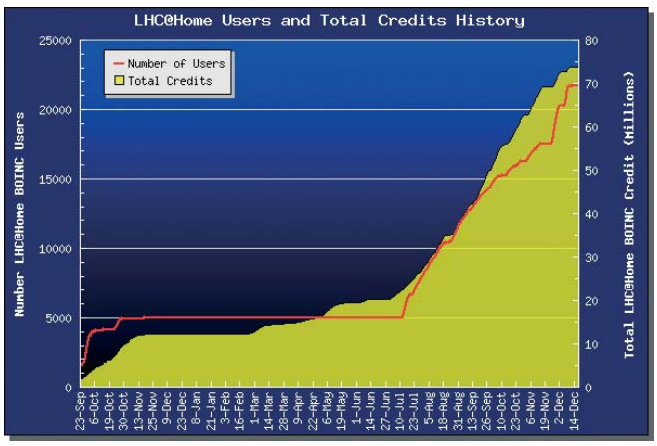
The research on resource virtualization has been started with the deployment of Xen server software which will flexibly allow researchers to develop and test software on virtual machines. The Xen virtualization technology allows running multiple virtual machines on one physical machine. This is very useful, e.g., when different Linux distributions are required in the test environment. Installation of an environment or duplicating an environment by a virtual server is much faster than on a physical machine, which speeds testing and development.

In late 2005 the HIP Technology Programme decided to join the Planet-Lab collaboration. Planet-Lab contains more than 600 computers in over 300 sites world-wide. Planet-Lab computers are centrally controlled and they run a common software package based on the Linux operating system. As such, it differs from many other Grid systems that have large local autonomy. The Programme offers two modern computers for Planet-Lab use and have access to the whole Planet-Lab network. The Planet-Lab computers will be used for testing distributed applications that are under development in the group (e.g., GB-DISK, GB-Agent). The Programme also acquired a disk server that will mainly be used to store the data needed in physics experiments. The server is located in the HIP headquarters in Kumpula. The storage capacity will be connected to NorduGrid. In addition, the server offers a good test environment for DataGrid applications.

The Programme has also continued collaboration with the Helsinki Institute of Information Technology (HIIT) on a search engine research project (Search-in-a-Box). The efforts have been channeled to the parallelization of the semantic discovery tool of the search engine. HIIT software has been run on the group's clusters to test the parallel code and the performance of the version compared to the serial version of the program. In addition to some real tests with real data the main use of the clusters has been in supporting the development of the software.

CMS Software, Physics and the LHC Grid

The HIP Technology Programme has strongly participated in the development of LHC@home. HIP's researchers and summer trainees worked in the initial set-up of the system. After that Dr. Klem has been contributing in many ways to the project. Public resource computing (also called "volunteer computing") uses computing power donated by the general public for scientific research. The LHC@home project runs an application to study the stability of particle motion in the Large Hadron Collider (LHC). LHC@home has been very popular and it has more than 20,000 users offering more than 40,000 computers producing several Teraflops of computing power. The results obtained from the simulation give the dynamic aperture of the LHC accelerator in the presence of magnet errors and beam-to-beam forces. The large computing capacity offered by LHC@home allows the accelerator physicists to make more detailed studies than could be done by dedicated resources available at CERN. The LHC@home resources are very low cost since CERN does not pay for the hardware or for the electrical power. The Technology Programme has participated in the building of the LHC@home server, in its operation and in



Histogram of the number of LHC@home users and total credits in 2005.

the search for new high energy physics applications for the set-up.

Physics Experimental Data Export (PhEDEx) is a tool for scalable and reliable distribution of CMS experiment data. The main components of PhEDEx are a transfer management database and a number of software agents. The transfer agents manage the movement of data files between different sites that host the data. There are also many other agents that, e.g., migrate files to mass storage, calculate checksums and register files into catalogues. PhEDEx and related tools such as the POOL file catalogue has been deployed in the HIP computers. This allows Finnish scientists to transfer large data sets easily. The users only have to fill in a web form after which PhEDEx moves the requested data to a storage element. The PhEDEx installation uses Grid software from both the NorduGrid ARC and LHC Computing Grid (LCG) projects. The Technology Programme has deployed and operated the PhEDEx software and the related storage elements.

The HIP Technology Programme's official visit to CSCS in Manno in June.

Industrial and research collaboration, outreach

After the successful NETGEST project with Finnish academic and industry partners, the Programme continued TEKES-funded industrial Grid development project activities within the NETGATE project. As a new feature, NETGATE added an unseen dimension to HIP's technology transfer activities by facilitating CERN OpenLab contributor memberships for two Finnish IT companies. The collaboration agreements between F-Secure, Stonesoft, HIP and CERN OpenLab were established during 2005 and will take effect from the beginning of 2006. Within NETGATE, HIP researchers continued to further develop Grid security middleware towards compliancy with emerging information and communication technology (ICT) standards.

Industrial research collaboration resulted in a number of supporting memberships, namely with the Mobile 3G test network Octopus, JBoss Federation and the previously mentioned Planet-Lab initiative. HIP will be a co-founder of a new registered association with CSC and VTT called FennoGrid. The aim of the FennoGrid association is to increase the coordinated dissemination of national and international Grid activities in Finland.

Other research of the group includes the Semantic Web/Grid in co-operation with VTT and the University of Tampere, and applying erasure correcting codes to Grid data storage in co-operation with CERN, the University of Delaware, and the University of Lugano. One researcher of the group completed his Master's thesis on a mobile Grid application for accessing satellite imaginary for UNOSAT.

The 2005 summer student programme welcomed six students from Helsinki University of Technology, the University of Tampere, Arcada Polytechnic and the University of Lappeenranta. Two out of the six students participated in CERN OpenLab-initiated industrial collaboration projects, while four remained in the Technology Programme.

Administration

Mikko Sainio

The graduate education of physics students continues to be one of the main tasks of the Institute. During the past year HIP has collaborated with one graduate school sponsored by the Ministry of Education: The Graduate School in Particle and Nuclear Physics (GRASPANP). In addition to the graduate students that are supported by the graduate school and by the Institute, also a large number of undergraduate students join the research groups and complete their Masters' thesis work in the Institute. Many of these students have continued as graduate students in the Institute projects upon graduation. In particular, the very popular summer student jobs at CERN have attracted students to graduate studies. During the period 2001–2005 30 doctoral degrees and 43 Masters' degrees have been earned in HIP research projects.

The National Board of Education (Opetushallitus) has continued the collaboration with HIP and the city of Jyväskylä in the CERN co-operation high school network and in the collaboration with the city of Helsinki in the TekNatur/CERN network for Swedish speaking students. The aim is to develop the role of particle physics in school curricula in co-operation with CERN. In 2005 this programme attracted 239 Finnish students and 35 of their teachers. A related programme has been to bring to CERN high school physics teachers, who participate in continuing education courses. In 2005, 16 teachers participated in this programme. In addition, a shorter visit to CERN was made by a group of 11 high school principals. These visits have generated considerable coverage in local newspapers all over the country: about 50 articles in total in 2005.

In September the Otaniemi team of the Technology Programme moved from the Ekono building (Tekniikantie 4) to a new location in the Innopoli2 building at Tekniikantie 14.

The technological and commercial co-operation between Finnish industry and CERN is co-ordinated by HIP in collaboration with Finpro, which is an independent association that provides services to Finnish export industry. The Finpro project at CERN is financed by TEKES.

Organization and Personnel

Organization

Scientific Advisory Board
Wolf-Dieter Schlatter, Heinrich Leutwyler, Maurice Rice, Jos Engelen, Martti Mäenpää, Hans Specht

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Dan-Olof Riska

Administrative Manager
Mikko Sainio

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  - Particle Physics Phenomenology — Katri Huitu
  - Cosmology — Kari Enqvist
  - Physics of Biological Systems — Ilpo Vattulainen
  - Ultrarelativistic Heavy Ion Collisions — Kari J. Eskola
- **High Energy Physics** — Heimo Saarikko
  - Electron-Positron Physics — Kenneth Österberg
  - LHC Foward Physics — Risto Orava
- **CMS** — Jorma Tuominiemi
  - Software and Physics — Veikko Karimäki
  - CMS Tracker — Eija Tuominen
- **Nuclear Matter Physics** — Juha Äystö
  - ALICE — Markku Oinonen
  - ISOLDE — Ari Jokinen
- **Technology** — Ari-Pekka Hameri
  - Data Grid — Miika Tuisku

The Board: Julin, Huitu, Keinonen, Makarow, Nevanlinna (substitute member).

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Vice Chairman	**Mauri Airila**, Vice Rector (until 31.7.2005) (Helsinki University of Technology)
	Kalevi Ekman, Vice Rector (starting 1.8.2005) (Helsinki University of Technology)
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	Juhani Keinonen, Professor (University of Helsinki)
	Antti Kupiainen, Professor (University of Helsinki)
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	Peter Lund, Professor (Helsinki University of Technology)
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Martti Mäenpää, Director General (Technology Industries of Finland)

Maurice Rice, Professor (ETHZ)

Hans Specht, Professor (U. Heidelberg)

Personnel

Theory Programme

K. Enqvist, prof., programme director
A. Green, prof., adj. senior scientist
A. Collin, grad. student
O. Dannenberg, grad. student
J. Koponen, grad. student

Cosmology

K. Enqvist, prof., proj. leader
F. Vernizzi, scientist
J. Högdahl, grad. student
T. Koivisto, grad. student
T. Mattsson, grad. student
V. Muhonen, grad. student
T. Poutanen, grad. student
A. Väihkönen, grad. student
J. Väliviita, grad. student
L. Mether, student
V. Reijonen, student
T. Tahkokallio, student

Particle Physics Phenomenology

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J. Maalampi, prof., adj. senior scientist
E. Gabrielli, senior scientist
Q. Li, scientist
S. Roy, scientist
T. Honkavaara, grad. student
J. Laamanen, grad. student
T. Rüppell, grad. student

Physics of Biological Systems

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J. Repáková, scientist
E. Terämä, grad. student
J. Aittoniemi, student
M. Heikelä, student
M. Kupiainen, student
T. Laurila, student
S. Ollila, student

String Theory and Quantum Field Theory

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A. Niemi, prof., adj. senior scientist
P. Prešnajder, senior scientist
B. Carneiro da Cunha, scientist
S. Kawai, scientist
J. Majumder, scientist
A. Tureanu, scientist
J.-T. Yee, scientist
N. Jokela, grad. student
T. Liimatainen, student

Ultrarelativistic Heavy Ion Collisions

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V. Ruuskanen, prof., senior scientist
K. Rummukainen, prof., adj. scientist
P. Huovinen, senior scientist
M. Strickland, senior scientist
V. Kolhinen, scientist
T. Lappi, scientist
T. Renk, scientist
K. Tuominen, scientist
A. Hietanen, grad. student
H. Niemi, grad. student
H. Paukkunen, student

High Energy Physics Programme

H. Saarikko, prof., programme director

Electron-Positron Physics

K. Österberg, proj. leader
J. Paro, scientist
L. Salmi, grad. student
F. Oljemark, student

LHC Forward Physics

R. Orava, prof., proj. leader
N. van Remortel, adj. scientist
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M. Eräluoto, grad. student
T. Hilden, grad. student
J. Kalliopuska, grad. student
P. Mehtälä, grad. student
T. Mäki, grad. student
E. Noschis, grad. student

Detector Laboratory

M. Oinonen, lab. coordinator
F. Garcia, scientist
J. Heino, lab. engineer
K. Kurvinen, lab. engineer
R. Lauhakangas, lab. engineer
J. Ojala, researcher
A. Numminen, lab. technician
E. Hujala, student

CMS Programme

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M. Stettler, senior scientist engineer (at CERN)

Software and Physics

V. Karimäki, docent, proj. leader (at CERN)
R. Kinnunen, senior scientist
K. Lassila-Perini, senior scientist (at CERN)
S. Lehti, senior scientist
T. Lindén, senior scientist, grid coordinator (from 1.7.2005)
A. Heikkinen, grad. student
A. Kumar Srivastava, grad. student (CIMO Scholar)
T. Lampén, grad. student (at CERN)
J. Nysten, grad. student (at CERN)
M. Voutilainen, grad. student (Fermilab)
L. Wendland, student
T. Aaltonen, summer trainee (at CERN)
P. Kaitaniemi, summer trainee (at CERN)
S. Saarinen, summer trainee (at CERN)

CMS Tracker

E. Tuominen, proj. leader (from 1.9.2005)
E. Hæggström, docent, proj. leader (at CERN) (until 31.8.2005)
S. Czellar, senior scientist (at CERN)
J. Härkönen, senior scientist (at CERN)
I. Kassamakov, senior scientist
H. Katajisto, scientist
A. Kesti, scientist
D. Ungaro, scientist (at CERN)
P. Luukka, grad. student (at CERN)
T. Mäenpää, grad. student
E. Tuovinen, grad. student
E. Anttila, student (at CERN)
T. Laihomäki, student
O. Harjukelo, summer trainee (at CERN)
H. Hoffrén, summer trainee (at CERN)
H. Moilanen, summer trainee (at CERN)
V. Vehmaa, summer trainee (at CERN)
M. Österberg, summer trainee (at CERN)
J. Kortesmaa, lab. technician
A. Kuronen, lab. technician

Nuclear Matter Programme

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K. Peräjärvi, scientist, GSI/FAIR coordinator

ALICE

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Z. Radivojevic, scientist
M. Bondila, grad. student
H. Seppänen, grad. student
V. Lyapin, engineer
R. Vierimaa, student
S. Nikkinen, student

ISOLDE

A. Jokinen, docent, proj. leader
J. Äystö, prof.

Technology Programme

A.-P. Hameri, prof., programme director (at CERN)

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J. Hahkala, scientist (at CERN)
J. Karppinen, scientist (at CERN)
J. Klem, scientist (at CERN)
T. Niemi, scientist (at CERN)
J. White, scientist (at CERN)
M. Gindonis, scientist
M. Niinimäki, scientist
M. Silander, scientist
M. Pitkänen, grad. student (at CERN)
A. Ahvenlampi, student (at CERN)
J. Nylund, student (at CERN)
T. Näppilä, student (at CERN)
K. Perttilä, student (at CERN)
A. Solonen, student (at CERN)
K. Happonen, student
H. Mikkonen, student
T. Nissi, student
A. Pirinen, student
X. Wang, student

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M. Sainio, docent, adm. manager
T. Sandelin, financial manager
M. Flygar, secretary (at CERN)
T. Hardén, secretary
T. Karppinen, secretary (at CERN)
P. Lehto, secretary
A. Heikkilä, tech. coordinator (at CERN)
R. Rinta-Filppula, researcher (at CERN)
N. Jiganova, IT specialist
J. Aaltonen, lab. engineer

Seminars

Seminars held in Helsinki

January 11th J. Poutanen (Astronomy Division, Oulu)
Accretion-powered millisecond pulsars

January 18th M. Strickland (HIP)
Instability driven thermalization of a QGP

January 25th M. Hyvönen (Wihuri Research Institute)
Computer simulation studies on lipid systems: towards information on lipoproteins

February 1st D. Milstead (Stockholm, Sweden)
The search for magnetic monopoles

February 8th A. Väihkönen (HIP)
Non-Gaussian cosmological perturbations from preheating

February 14th (Colloquium) J. Ritman (University of Bochum and FZ Juelich, Germany)
Upcoming hadron physics projects with internal targets – from WASA at COSY to PANDA at FAIR

February 15th D. Rischke (University of Frankfurt, Germany)
Single-inclusive spectra in A+A collisions from invariant phase space

February 22nd D. Ungaro (HIP)
HIP contribution to the CMS magnet test

March 8th K. Muinonen (Department of Astronomy)
Asteroid impact risk

March 18th B. Mueller (Duke University, USA)
Probing color deconfinement at RHIC

March 22nd A. Lushnikov (Department of Physical Sciences, Division of Atmospheric Sciences)
From "sol" to "gel"

April 11th (Colloquium) K. Kaila (Department of Biological and Environmental Sciences and Neuroscience Center)
Fat, proteins and salt water: material for elements in a "supercomputer" known as the brain

April 19th P. Howe (King's College, London, UK)
Born-Infeld dynamics, past and present

May 3rd J. Härkönen (HIP)
Development of radiation hard particle detectors

May 10th J.-P. Uzan (Institut d'Astrophysique de Paris, France)
Constants and their variation

May 16th T. Toimela (Vaasa University of Applied Sciences)
Anomalous nuclear reactions in metal deuterides and multiple resonance scattering

May 17th B. Carneiro da Cunha (HIP)
D0-branes currents and 2-d string theory

May 24th M. Voutilainen (University of Nebraska, USA/ HIP)
Production of high energy jets at the DZERO experiment at Fermilab

May 25th D. Diakonov (St. Petersburg Nuclear Physics Institute, Russia)
Instantons, monopoles and the confinement-deconfinement transition

June 1st C. Carlson (William-Mary, USA)
The 2-photon exchange story: reconciling different ways of measuring proton form factors

June 8th C. Aulakh (India)
MSGUTs from germ to bloom – towards falsifiability and beyond

June 13th (Colloquium) Y. Nambu (University of Chicago, USA)
Broken symmetries in physics

June 14th T. Renk (Duke University, USA)
Hunting the quark-gluon plasma - bulk matter dynamics at RHIC

June 21st A. Melchiorri (Rome, Italy)
Constraints on neutrino physics from cosmology and their impact on world neutrino data

July 26th M. Nitta (Tokyo Inst. of Tech., Japan)
BPS solitons in the Higgs phase and their D-brane configuration

August 16th O. W. Greenberg (University of Maryland, USA)
Failure of microcausality in quantum field theory on noncommutative spacetime

September 6th T. Poutanen (HIP/Department of Physical Sciences)
Mapping of the anisotropies of the cosmic microwave background

September 9th A. Nikitenko (Imperial College, UK)
Higgs search at LHC

September 13th F. Vernizzi (HIP)
What do cosmological perturbations tell us about the early universe?

September 15th A. Sibirtsev (Juelich, Germany)
Phi photoproduction – direct evidence of QCD

September 20th P. Törmä (Department of Physics, Nanoscience Center, University of Jyväskylä)
Main course: superfluidity of ultracold Fermi gases, dessert: molecular electronics with DNA

September 27th K. Lassila-Perini (HIP)
Physics before discoveries at the LHC?

October 4th U. Maor (Tel Aviv University, Israel)
Gap survival probability

October 11th N. Jokela (HIP)
Superstring scattering from decaying branes

October 18th K. Nordlund (Department of Physical Sciences, Accelerator Laboratory)
Strings, interstitials, and why liquids exist?

October 20th H. Machner (University Duisburg-Essen and Inst. f. Kernphysik, FZ Juelich, Germany)
Present and future at COSY

October 25th K. Kajantie (Department of Physical Sciences, Division of Theoretical Physics)
The initial state of little bang

November 8th J.-T. Yee (HIP)
Bubbling AdS_2

November 15th J. Laamanen (HIP)
Some tests of physics beyond the Standard Model

November 22nd T. Vesala (Department of Physical Sciences, Division of Atmospheric Sciences)
Micrometeorology and environmental physics: from Karman vortex streets to phloem mass transport

December 13th E. Gabrielli (HIP)
Light mesons and muon radiative decays and photon polarization asymmetry

Visitors

Theory Programme

Cosmology

A. Rajantie (UK) 20.12.04.-20.1.05.
F. Ravndal (Norway) 13.-21.1.
K. Rummukainen (Switzerland) 14.-16.1.
M. Sloth (USA) 18.4.-9.5.
J. P. Uzan (France) 5.-11.5.
S. Mohanty (India) 1.-31.8.

Particle Physics Phenomenology

D. Milstead (Sweden) 31.1.-1.2.
P. N. Pandita (India) 3.-22.2.
C. Aulakh (India) 5.-10.6.
J. M. Rivera (Mexico) 22.-28.6.
P. Osland (Norway) 21.-23.12.

Hadron Physics Activity

B. S. Zou (PR China) 31.1.-5.3.
J. Ritman (Germany) 14.-16.2.
V. Abaev (Russia) 14.3.-22.4.
E. Norvaišas (Lithuania) 21.-24.3.
C. Carlson (USA) 28.5.-5.6.
E. Norvaišas (Lithuania) 19.-23.9.
V. Abaev (Russia) 3.10.-11.11.
B. S. Zou (PR China) 31.10.-30.11.
S. Wycech (Poland) 2.-30.11.

Physics of Biological Systems

T. Heimburg (Denmark) 16.-18.1.
J. Repáková (Czech Republic) 20.-26.2.
J. Yeomans (UK) 14.-16.3.
P.-L. Hansen (Denmark) 23.-30.5.
R. Metzler (Denmark) 24.5.
S. Lyulin (Russia) 1.8.-31.12.
P. B. S. Kumar (India) 9.-12.10.
P. B. S. Kumar (India) 7.-10.12.
O. G. Mouritsen (Denmark) 7.-11.12.
P.-L. Hansen (Denmark) 7.-14.12.

String Theory and Quantum Field Theory

K. Nishijima (Japan) 14.-20.1.
L. Jarv (Estonia) 13.-17.2.
M. Mnatsakanova (Russia) 6.3.-4.4.
Yu. Vernov (Russia) 6.3.-4.4.
O. W. Greenberg (USA) 27.5.-21.8.
Y. Nambu (USA) 11.-16.6.
S. F. Ross (UK) 13.-25.6.
K. Nishijima (Japan) 26.7.-23.8.
P. Prešnajder (Slovakia) 1.-31.8.
J.-T. Yee (The Netherlands) 28.8.-2.9.
P. Prešnajder (Slovakia) 1.-21.10.
R. Zhang (Australia) 11.- 19.11.
M. Mnatsakanova (Russia) 13.11.- 31.12.
Yu. Vernov (Russia) 13.11.-31.12.

Ultrarelativistic Heavy Ion Collisions

J.-P. Blaizot (France) 6.-8.1.
P. Levai (Hungary) 9.-13.1.
C. Salgado (Switzerland) 17.-22.1.
D. H. Rischke (Germany) 13.-26.2.
Á. Mócsy (Germany) 19.-27.2.
B. Müller (USA) 18.3.
D. Diakonov (Russia) 25.5.
D. D. Dietrich (Denmark) 29.5.-3.6.
T. Renk (USA) 14.-18.6.
H. Stöcker (Germany) 11.-13.12.

High Energy Physics Programme

V. Khoze (UK) 31.1.-4.2.
U. Maor (Israel) 1.-5.10.
V. Avati (Switzerland) 7.-10.12.
K. Eggert (Switzerland) 7.-10.12.
M. Oriunno (Switzerland) 7.-10.12.
E. Rademacher (Switzerland) 7.-10.12.
L. Robelewski (Switzerland) 7.-10.12.

CMS Programme

Software and Physics

G. Snow (USA) 25.-27.5.
M. Asai (USA) 6.-7.6.
J. Perl (USA) 6.-7.6.
D. Wright (USA) 6.-7.6.
F. Flückiger (Switzerland) 17.-22.6.
A. Kumar Srivastava (India) 1.9.-30.11.

Nuclear Matter Programme

ALICE

Y. Dmitriev (Russia) 23.-27.1.
V. Grigoriev (Russia) 23.-27.1.
N. Chernykova (Ukraine) 26.1.-25.2.
M. Protsenko (Ukraine) 26.1.-25.2.
S. Vlasenko (Ukraine) 26.1.-25.2.
I. Tymchuk (Ukraine) 22.2.-26.3.
L. Klimova (Ukraine) 1.-25.3.
M. Tykhomyrova (Ukraine) 1.-25.3.
V. Zhupinsky (Ukraine) 1.-25.3.
J. Rak (USA) 12.-13.3.
V. Kaplin (Russia) 28.3.-4.4.
O. Chykalov (Ukraine) 11.4.-23.5.
Y. Kostyshyn (Ukraine) 11.4.-23.5.
A. Tsenner (Ukraine) 11.4.-23.5.
I. Tymchuk (Ukraine) 29.5.-11.7.
D. Isichenko (Ukraine) 30.5.-9.7.
S. Pankov (Ukraine) 30.5.-9.7.
N. Chernykova (Ukraine) 27.6.-31.7.
Y. Kostyshyn (Ukraine) 10.7.-23.8.
M. Protsenko (Ukraine) 10.7.-23.8.
S. Senyukov (Ukraine) 10.7.-23.8.
B. Cheynis (France) 1.-8.8.
J.-Y. Grossior (France) 1.-8.8.
R. Tieulent (France) 1.-8.8.
W. Tromeur (France) 1.-8.8.
Y. Zoccarato (France) 1.-8.8.
A. Tsenner (Ukraine) 28.8.-8.10.
I. Tymchuk (Ukraine) 28.8.-8.10.
N. Chernykova (Ukraine) 11.9.-8.10.
Y. Shulenko (Ukraine) 11.9.-8.10.
L. Klimova (Ukraine) 17.10.-17.11.
O. Striliana (Ukraine) 17.10.-17.11.
Y. Kostyshyn (Ukraine) 17.10.-29.11.
M. Protsenko (Ukraine) 17.10.-29.11.
Y. Rosenko (Ukraine) 14.11.-22.12.
V. Zhupinsky (Ukraine) 14.11.-22.12.
N. Chernykova (Ukraine) 28.11.-24.12.
S. Pankov (Ukraine) 28.11.-24.12.
I. Tymchuk (Ukraine) 28.11.-24.12.
G. Prete (Italy) 4.-9.12.
A. Klimov (Russia) 15.-16.12.

Conference participation, Talks and Visits by Personnel

Theory Programme

Cosmology

Centre de Physique Theorique (CPT),
17 January, Marseille, France (talk by F. Vernizzi)

Planck Consortia Meeting, Max Planck Institute for Astrophysics (MPA),
26-29 January, Garching, Germany (T. Poutanen)

4th Nordic Winter School on Particle Physics and Cosmology,
2-8 February, Gausdal, Norway (T. Koivisto)

NORDITA,
4-9 March, Copenhagen, Denmark (talk by F. Vernizzi)

The Origin of the Primordial Density Perturbation,
22-24 March, Lancaster, UK (J. Högdahl, talk by F. Vernizzi, talk by A. Väihkönen)

University of Stockholm,
1-2 April, Stockholm, Sweden (talk by K. Enqvist)

Workshop: Facts and Fiction in Cosmology,
8-17 April, Sils Maria, Switzerland (talk by F. Vernizzi)

University of Geneva,
18-23 April, Geneva, Switzerland (F. Vernizzi)

Institut d'Astrophysique de Paris (IAP),
1-4 May, Paris, France (F. Vernizzi)

Institut d'Astrophysique de Paris (IAP),
11-14 May, Paris, France (F. Vernizzi)

Planck CTP Working Group Meeting, Institut d'Astrophysique de Paris (IAP),
6-11 June, Paris, France (T. Poutanen)

Open Questions in Cosmology,
22-26 August, Garching, Germany (J. Väliviita)

COSMO-05,
28 August - 1 September, Bonn, Germany (talk by K. Enqvist, J. Högdahl, T. Mattsson, V. Muhonen, talk by F. Vernizzi, talk by A. Väihkönen, talk by J. Väliviita)

Institut d'Astrophysique de Paris (IAP),
9-29 October, Paris, France (F. Vernizzi)

University of Geneva,
26 November - 4 December, Geneva, Switzerland (F. Vernizzi)

Cosmology 2005: a reality check,
14-17 December, Copenhagen, Denmark (K. Enqvist, J. Högdahl, talk by T. Koivisto, T. Mattsson, V. Muhonen, V. Reijonen, talk by F. Vernizzi, A. Väihkönen)

Particle Physics Phenomenology

1st GUC Workshop on High Energy Physics,
5-11 January, Cairo, Egypt (invited talk by K. Huitu)

Joint Particle Physics and High Energy/Cosmology Seminar,
4 February, Helsinki, Finland (talk by S. Roy)

Harish-Chandra Research Institute,
10 February, Allahabad, India (talk by S. Roy)

Indian Association for the Cultivation of Science,
4 March, Kolkata, India (talk by S. Roy)

Saha Institute of Nuclear Physics,
7 March, Kolkata, India (talk by S. Roy)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (invited talk by K. Huitu)

Jyväskylä Physics Club Meeting,
27 April, Jyväskylä, Finland (invited talk by K. Huitu)

SAB-Meeting, CERN,
23-24 May, Geneva, Switzerland (K. Huitu)

Particle Physics Phenomenology Seminar,
26 May, Helsinki, Finland (talk by J. Laamanen)

Summer School on Particle Physics,
13-24 June, ICTP, Trieste, Italy (T. Honkavaara)

The 13th International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY2005),
18-23 July, IPPP, Durham, UK (talk by K. Huitu, talk by J. Laamanen, talk by S. Roy, T. Rüppell)

1st Workshop of Nordic Network of Women in Physics,
8-10 August, Bergen, Norway (invited talk by K. Huitu)

Physics Department, Parma University,
17 October, Parma, Italy (talk by E. Gabrielli)

Physics Department, Rome1 University,
20 October, Rome, Italy (talk by E. Gabrielli)

Flavour in the era of the LHC,
7-10 November, CERN, Geneva, Switzerland (E. Gabrielli)

Particle Physics Day,
18 November, Jyväskylä, Finland (K. Huitu, S. Roy, talk by T. Rüppell)

RECFA- and ECFA-Meetings, CERN,
1-2 December, Geneva, Switzerland (K. Huitu)

Inauguration, University of Helsinki,
7 December, Helsinki, Finland (invited talk by K. Huitu)

Hadron Physics Activity

Workshop on Hadronic Atoms,
15-16 February, Bern, Switzerland (invited talk by M. Sainio)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (talk by J. Koponen, D. O. Riska, M. Sainio)

European Graduate College: Complex Systems of Hadrons and Nuclei,
4-9 April, Copenhagen, Denmark (talk by J. Koponen)

Institute of Theoretical Physics, University of Bern,
4-7 May, Bern, Switzerland (M. Sainio)

Workshop on Hadron Physics at COSY,
25-29 July, Bad Honnef, Germany (invited talk by D. O. Riska, M. Sainio)

XXIIIrd International Symposium on Lattice Field Theory,
25-30 July, Dublin, Ireland (J. Koponen)

New Theoretical Tools for Nucleon Resonance Analysis Workshop,
29 August - 2 September, Argonne, IL, USA (invited talk by D. O. Riska)

The 6th European Research Conference: Electromagnetic Interactions with Nucleons and Nuclei,
21-24 September, Milos, Greece (talk by A. M. Green)

Symposium Celebrating Fritz Coester's Contributions to Theoretical Physics,
30 September, Iowa City, IA, USA (invited talk by D. O. Riska)

Workshop on Nucleon Form Factors,
12-14 October, Frascati, Italy (invited talk by D. O. Riska)

Particles and Nuclei International Conference,
24-28 October, Santa Fe, NM, USA (invited talk by D. O. Riska, talk by M. Sainio)

Institute of Theoretical Physics, University of Bern,
4-6 December, Bern, Switzerland (M. Sainio)

Physics of Biological Systems

Biophysical Society 49th Annual Meeting,
12-16 February, Long Beach, CA, USA (E. Terämä, I. Vattulainen)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (M. T. Hyvönen, M. Heikelä, M. Kupiainen, S. Ollila, E. Terämä, I. Vattulainen)

Lipid Forum 2005,
1 April, Helsinki, Finland (I. Vattulainen)

Biomembrane Organization and Protein Function -From Computation to Experiment,
4-6 April, CECAM, Lyon, France (I. Vattulainen)

CSC Nanoworkshop,
19 May, Espoo, Finland (talk by I. Vattulainen)

Computational Problems in Physics 2005,
23-27 May, Helsinki, Finland (I. Vattulainen)

Modeling of Biomolecular Systems - International Summer School,
30 May - 1 June, Kiljava, Finland (J. Aittoniemi, M. Heikelä, M. T. Hyvönen, M. Kupiainen, S. Ollila, J. Repáková, organized by I. Vattulainen)

Diffusion Fundamentals,
22-24 September, Leipzig, Germany (talk by I. Vattulainen)

Jyväskylä Nanoscience Days,
27-28 October, Jyväskylä, Finland (talk by I. Vattulainen)

String Theory and Quantum Field Theory

Symposium in the Honour of the 70th Birthday of Julius Wess, Max-Planck Institute,
8-13 January, Munich, Germany (M. Chaichian, A. Tureanu)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (N. Jokela, talk by E. Keski-Vakkuri)

Sakharov Conference,
8-17 April, Moscow, Russia (M. Chaichian)

Tamm International Conference on Theoretical Physics,
11-16 April, Moscow, Russia (invited talk by A. Tureanu)

String Cosmology Workshop,
24-28 April, Uppsala, Sweden (B. Carneiro da Cunha, N. Jokela, S. Kawai, invited talk by E. Keski-Vakkuri, J. Majumder)

DESY,
29-30 April, Hamburg, Germany (M. Chaichian)

Workshop on Gravitational Aspects of String Theory, The Fields Institute,
2-6 May, Toronto, Canada (E. Keski-Vakkuri)

Symposium in the Honour of Yuval Ne'eman's 80th Birthday, Tel Aviv University,
16-24 May, Tel Aviv, Israel (M. Chaichian)

Summer School on Strings, Gravity and Cosmology,
20 June - 8 July, Waterloo, Canada (N. Jokela)

Strings 2005,
11-16 July, Toronto, Canada (N. Jokela, J. Majumder)

European Physical Society High Energy Physics Conference, EPS HEP05,
20-27 July, Lisbon, Portugal (M. Chaichian, talk by A. Tureanu)

University of Pennsylvania,
24 July - 3 August, Philadelphia, PA, USA (invited seminar by E. Keski-Vakkuri)

Dept. of Physics, Indian Institute of Technology,
5 September, Roorkee, India (seminar by J. Majumder)

Dept. of Physics, University of Delhi,
6 September, Delhi, India (seminar by J. Majumder)

Dept. of Physics, Indian Institute of Technology,
8 September, Mumbai, India (seminar by J. Majumder)

Center for High Energy Physics, Indian Institute of Science,
12 September, Bangalore, India (seminar by J. Majumder)

Dept. of Physics, Indian Institute of Technology,
14 September, Kanpur, India (seminar by J. Majumder)

Harish-Chandra Research Institute,
15 September, Allahabad, India (seminar by J. Majumder)

Indian Association for the Cultivation of Science,
17-24 September, Jadavpur, Kolkata, India (J. Majumder)

Cosmic Strings and Fundamental Strings,
22-27 September, Paris, France (N. Jokela)

University of Vienna,
28 September - 3 October, Vienna, Austria (M. Chaichian)

Einstein Conference, Universities of Bucharest and Iasi,
20-31 October, Bucharest and Iasi, Romania (invited talk and seminar by M. Chaichian, talk by A. Tureanu)

20th Nordic String Network Meeting,
27-28 October, Helsinki, Finland (organizer N. Jokela, organizer E. Keski-Vakkuri, J. Majumder, J.-T. Yee)

University of Stockholm and the Royal Institute of Technology,
6-7 December, Stockholm, Sweden (M. Chaichian)

Ultrarelativistic Heavy Ion Collisions

Niels Bohr Institute,
7-14 January, Copenhagen, Denmark (talk by K. Tuominen)

Duke University,
12-15 January, Durham, NC, USA (T. Lappi)

Ohio State University,
17-19 January, Columbus, OH, USA (T. Lappi)

BNL,
20-21 January, Long Island, NY, USA (T. Lappi)

CERN,
6-14 February, Geneva, Switzerland (K. Kajantie)

FIN-ALICE Meeting,
21 March, Jyväskylä, Finland (K. J. Eskola, P. Huovinen, V. J. Kolhinen, talk by H. Niemi, V. Ruuskanen, K. Tuominen)

2nd International Workshop on the Critical Point and Onset of Deconfinement,
30 March - 3 April, Bergen, Norway (talk by H. Niemi)

European Graduate College: Complex Systems of Hadrons and Nuclei,
4-8 April, NBI, Copenhagen, Denmark (H. Paukkunen)

Site visit of the Academy of Finland CoE application review board,
14 April, Helsinki, Finland (talk by K. J. Eskola, K. Kajantie, talk by H. Niemi, K. Tuominen)

DIS2005: XIII International Workshop on Deep Inelastic Scattering,
24 April - 1 May, Madison, WI, USA (invited talk by V. J. Kolhinen)

MIT,
2 May, Boston, MA, USA (V. J. Kolhinen)

Department of Physics, University of Jyväskylä,
13 May, Jyväskylä, Finland (T. Lappi)

Frankfurt Institute for Advanvced Studies,
6-12 June, Frankfurt, Germany (talk by K. Tuominen)

CERN,
20 July - 1 August, Geneva, Switzerland (K. Kajantie)

DESY, Summer Student Program,
20 July - 13 September, Zeuthen, Germany (talk by H. Paukkunen)

The XVIII International Conference on Nucleus-Nucleus Collisions; Quark Matter 2005,
4-9 August, Budapest, Hungary (K. J. Eskola, K. Kajantie, talk by T. Lappi, talk by H. Niemi, K. Tuominen)

Workshop on Quark-Gluon-Plasma Thermalization,
10-12 August, Vienna, Austria (K. Kajantie, talk by T. Lappi)

HETP Seminar at JYFL,
28 September, Jyväskylä, Finland (talk by K. Tuominen)

HETP Seminar at JYFL,
12 October, Jyväskylä, Finland (talk by M. Strickland)

Particle Physics Day,
18 October, Jyväskylä, Finland (K. J. Eskola, K. Kajantie, V. J. Kolhinen, H. Niemi, talk by H. Paukkunen, talk by T. Renk, P. V. Ruuskanen, K. Tuominen)

Niels Bohr Institute,
6-12 November, Copenhagen, Denmark (K. Tuominen)

HETP Seminar at JYFL,
23 November, Jyväskylä, Finland (talk by T. Renk)

High Energy Physics Programme

Electron-Positron Physics

HERA and the LHC -Workshop, CERN Meeting,
17-21 January, CERN, Geneva, Switzerland (talk by K. Österberg)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (L. Salmi, K. Österberg)

HERA and the LHC -Workshop, Summary Meeting,
21-24 March, Hamburg, Germany (talk by K. Österberg)

Meeting of the Finnish CLIC R&D Industrial Network,
28 October, Tampere, Finland (talk by J. Paro, K. Österberg)

Particle Physics Day,
18 November, Jyväskylä, Finland (talk by F. Oljemark, K. Österberg)

Euromold World Fair,
30 November - 3 December, Frankfurt, Germany (J. Paro)

Working visits to Finnish CLIC R&D Industrial Partners,
Riihimäki, Tampere and Espoo, Finland (J. Paro)

Forward Physics

ITER Workshop,
31 January, Espoo, Finland (invited seminar by R. Orava)

Top Mass Meeting,
16 February, Fermilab, IL, Batavia, USA (talk by P. Mehtälä)

All-hadronic Meeting,
17 February, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

EU-RTN Workshop,
22-25 February, Karlsruhe, Germany (talk by N. van Remortel)

University of Helsinki,
28 February, Helsinki, Finland (talk by P. Mehtälä)

Top Mass Meeting,
16 March, Fermilab, Batavia, IL, USA (talk by T. Mäki)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (talk by P. Mehtälä, talk by N. van Remortel)

Particle Physics Seminar,
6 April, Helsinki, Finland (talk by P. Mehtälä)

The Annual April Meeting of the American Physical Society,
15-19 April, Tampa, FL, USA (talk by T. Mäki)

Top Mass Meeting,
20 April, Fermilab, Batavia, IL, USA (talk by T. Mäki)

CDF Tracking Meeting,
20 April, Fermilab, Batavia, IL, USA (talk by N. van Remortel)

The 420 m Workshop,
26 April, Fermilab, Batavia, IL, USA (talk by R. Orava)

Top Mass Meeting,
4 May, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Top Group Meeting,
12 May, Fermilab, Batavia, IL, USA (talk by T. Mäki)

The 2005 CTEQ Summer School,
19-27 May, Puebla, Mexico (T. Mäki)

Top Mass Meeting,
8 June, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Silicon Operations Meeting,
16 June, Fermilab, Batavia, IL, USA (talk by T. Mäki)

CDF Tracking Meeting,
16 June, Fermilab, Batavia, IL, USA (talk by N. van Remortel)

Top Mass Meeting,
22 June, Fermilab, Batavia, IL, USA (talk by T. Mäki)

All-hadronic Meeting,
23 June, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

Workshop on Low-x Physics,
28 June - 2 July, Sinaia, Romania (invited talk by R. Orava)

Top Mass Meeting,
6 July, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

Silicon Operations Meeting,
13 July, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Top Group Meeting,
14 July, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Simulation Meeting,
14 July, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

CDF Tracking Meeting,
14 July, Fermilab, Batavia, IL, USA (talk by N. van Remortel)

Silicon Operations Meeting,
18 July, Fermilab, Batavia, IL, USA (talk by T. Mäki)

All-hadronic Meeting,
21 July, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

The XXXV International Symposium on Multiparticle Dynamics,
9-15 August, Kromeriz, Czech Republic (invited talk by R. Orava)

The 2005 European School of High Energy Physics,
21 August - 3 September, Kitzbühel, Austria (T. Mäki)

EU-RTN Computing and GRID work visit,
26 August, Rovaniemi, Finland (N. van Remortel)

Particle Physics Seminar,
2 September, Helsinki, Finland (seminar by N. van Remortel)

Particle Physics Seminar,
9 September, Helsinki, Finland (seminar by N. van Remortel)

The CMS-TOTEM Workshop,
23 September, CERN, Geneva, Switzerland (invited talk by R. Orava)

Silicon Operations Meeting,
3 October, Fermilab, Batavia, IL, USA (talk by T. Mäki)

CDF Tracking Meeting,
12 October, Fermilab, Batavia, IL, USA (talk by N. van Remortel)

Particles and Nuclei International Conference,
24-28 October, Santa Fe, NM, USA (talk by T. Mäki)

Particle Physics Day,
18 November, Jyväskylä, Finland (talk by T. Aaltonen and T. Hilden, N. van Remortel)

Top Group Meeting,
1 December, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Silicon Operations Meeting,
19 December, Fermilab, Batavia, IL, USA (talk by T. Mäki)

Detector Laboratory

ESA-ESTEC GEANT4 SPACE USER Meeting,
3-4 February, Noordwijk, The Netherlands (talk by F. Garcia)

TKK-ITER Meeting,
29 February, Espoo, Finland (talk by F. Garcia)

2nd Finnish GEANT4 Workshop,
6-7 June, Helsinki, Finland (talk by F. Garcia)

CSC Finnish IT Center for Science Workshop,
20 September, Espoo, Finland (F. Garcia)

Particle Physics Seminar,
1 December, Helsinki, Finland (talk by F. Garcia)

TOTEM Collaboration Meeting,
8-9 December, Helsinki, Finland (talk by F. Garcia)

CMS Programme

Software and Physics

Second Nordic Grid Neighborhood Workshop,
20 January, Tallinn, Estonia (T. Lindén)

Stanford Linear Accelerator Center,
28 January - 6 February, Menlo Park, CA, USA (A. Heikkinen)

Higgs Working Group Meeting,
9 February, CERN, Geneva, Switzerland (talk by S. Lehti)

Higgs Working Group,
13 February, CERN, Geneva, Switzerland (talk by R. Kinnunen)

Tracker Alignment Meeting,
15 February, CERN, Geneva, Switzerland (talk by V. Karimäki, talk by T. Lampén)

Department of Physics, University of Jyväskylä,
24-26 February, Jyväskylä, Finland (invited seminar by A. Heikkinen)

Meeting of Restricted ECFA,
25-27 February, Warsaw, Poland (J. Tuominiemi)

Tracker Alignment Meeting,
3 March, CERN, Geneva, Switzerland (talk by V. Karimäki)

M-grid Administrator Meeting,
11 March, Turku, Finland (T. Lindén)

Higgs Working Group,
15 March, CERN, Geneva, Switzerland (talk by R. Kinnunen)

Pixel Test Beam and PTDR Meeting,
15 March, CERN, Geneva, Switzerland (talk by V. Karimäki)

ECAL Meeting, CMS Week,
16 March, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (A. Heikkinen, V. Karimäki, T. Lampén, J. Nysten)

Electron Photon Meeting,
23 March, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

CMS Physics Week at Fermilab,
10-16 April, Batavia, IL, USA (talk by S. Lehti)

Higgs Working Group,
12 April, CERN, Geneva, Switzerland (talk by R. Kinnunen)

Nordic Data Grid Facility (NDGF) Evaluation Panel,
15-16 April, Copenhagen, Denmark (V. Karimäki)

Monte Carlo 2005 Topical Meeting,
16-23 April, Chattanooga, TN, USA (talk by A. Heikkinen)

Tracker Alignment Meeting,
19 April, CERN, Geneva, Switzerland (talk by T. Lampén)

Department of Physics and Astronomy, University of Nebraska in Lincoln,
28 April, Lincoln, NE, USA (talk by M. Voutilainen)

Les Houches Workshop: Physics at TeV Colliders,
2-20 May, Les Houches, France (talk by S. Lehti)

Tracker Alignment Meeting,
3 May, CERN, Geneva, Switzerland (talk by T. Lampén)

Higgs Working Group,
12 May, CERN, Geneva, Switzerland (talk by R. Kinnunen)

C-Rack Software Meeting,
12 May, CERN, Geneva, Switzerland (talk by T. Lampén)

Unix Computing in High Energy Physics (HEPiX spring 2005),
11-13 May, Karlsruhe, Germany (T. Lindén)

Meeting of EPS HEPP Board,
13 May, CERN, Geneva, Switzerland (J. Tuominiemi)

Meeting of Restricted ECFA,
20-21 May, Rehovoth, Israel (J. Tuominiemi)

X International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT05),
22-27 May, DESY, Hamburg, Germany (talk by A. Heikkinen)

M-grid Administrator Meeting,
27 May, Lappeenranta, Finland (talk by T. Lindén)

Tracker Alignment Meeting,
31 May, CERN, Geneva, Switzerland (talk by V. Karimäki, talk by T. Lampén)

Online Selection Meeting,
2 June, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

New Perspectives, Fermilab,
9-11 June, Batavia, IL, USA (talk by M. Voutilainen)

Standard Model Group Meeting,
10 June, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

DZero Summer Workshop, Simon Fraser University,
12-18 June, Burnaby, BC, Canada (talk by M. Voutilainen)

Tracker Alignment Meeting,
14 June, CERN, Geneva, Switzerland (talk by T. Lampén)

Tracker Alignment Meeting,
5 July, CERN, Geneva, Switzerland (talk by V. Karimäki)

Higgs Working Group,
8 July, CERN, Geneva, Switzerland (talk by R. Kinnunen)

Geant4 Symposium,
12-20 July, Genova, Italy (talk by A. Heikkinen)

Meeting of EPS HEPP Board,
25 July, Lisbon, Portugal (J. Tuominiemi)

SLAC Summer Institute, Stanford Linear Accelerator Center,
25 July - 5 August, Menlo Park, CA, USA (M. Voutilainen)

Standard Model Group Meeting,
29 July, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

BTau Tau tagging Meeting,
29 July, CERN, Geneva, Switzerland (talk by L. Wendland)

First Nordic Grid Neighbourhood Conference,
14-16 August, Oslo, Norway (T. Lindén)

The 2005 European School of High Energy Physics,
21 August - 3 September, Kitzbühel, Austria (J. Nysten)

Finnish grid strategy task force open hearing,
22 August, Espoo, Finland (T. Lindén)

M-grid Administrator Meeting,
26 August, Oulu, Finland (talk by T. Lindén)

Tracker Alignment Meeting,
6 September, CERN, Geneva, Switzerland (talk by T. Lampén)

CERN School of Computing 2005,
8-10 September, Saint Malo, France (V. Karimäki)

10th Annual RDMS Collaboration Conference,
10-17 September, PNPI, St-Petersburg, Russia (invited seminar by R. Kinnunen)

Frontier Science 2005,
11-18 September, Milano, Italy (invited talk by A. Heikkinen)

BTau Tau tagging Meeting, CMS Week,
19 September, CERN, Geneva, Switzerland (talk by L. Wendland)

Pixel software Meeting,
20 September, CERN, Geneva, Switzerland (talk by V. Karimäki)

ECAL Working Group, CMS Week,
21 September, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

CPT Plenary Session,
22 September, CERN, Geneva, Switzerland (talk by T. Lampén)

ROOT Workshop,
27-30 September, CERN, Geneva, Switzerland (F. Garcia, T. Lindén)

Higgs Working Group,
30 September, CERN, Geneva, Switzerland (talk by R. Kinnunen)

Workshop on Tracking in High Multiplicity Environment (TIME05),
3-7 October, Zürich, Switzerland (invited talk by T. Lampén)

BTau Meeting,
4 October, CERN, Geneva, Switzerland (talk by L. Wendland)

Meeting of EPS HEPP Board,
7 October, CERN, Geneva, Switzerland (J. Tuominiemi)

CMS Pixel Software Workshop at Fermilab,
10-12 October, Batavia, IL, USA (talk by V. Karimäki)

Higgs Working Group, CPT Week,
31 October, CERN, Geneva, Switzerland (talk by R. Kinnunen, talk by S. Lehti)

Vertex Meeting, CPT Week,
1 November, CERN, Geneva, Switzerland (talk by L. Wendland)

ECAL Working Group, CPT Week,
1 November, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

10th Geant4 Conference,
3-10 November, Bordeaux, France (scientific committee and invited talks by A. Heikkinen)

Meeting on Tracker alignment and PTDR VI,
7 November, CERN, Geneva, Switzerland (talk by V. Karimäki)

M-grid Administrator Meeting,
11 November, Espoo, Finland (T. Lindén)

All DZero Meeting,
11 November, Fermilab, Batavia, IL, USA (talk by M. Voutilainen)

BTau Meeting,
15 November, CERN, Geneva, Switzerland (talk by L. Wendland)

Particle Physics Day,
18 November, Jyväskylä, Finland (talk by T. Lampén)

Nordic Data Grid Facility (NDGF) Meeting,
29 November, Copenhagen, Denmark (T. Lindén)

Tracker/b-tau Meeting 2,
30 November, CERN, Geneva, Switzerland (talk by V. Karimäki)

BTau Tau tagging Meeting,
1 December, CERN, Geneva, Switzerland (talk by L. Wendland)

Higgs Working Group,
2 December, CERN, Geneva, Switzerland (talk by R. Kinnunen)

CMS Physics Meeting,
5 December, CERN, Geneva, Switzerland (talk by V. Karimäki)

CMS Physics Meeting,
7 December, CERN, Geneva, Switzerland (talk by T. Lampén)

ECAL Working Group, CMS Week,
12 December, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

AlbaNova University Center, University of Stockholm,
15 December, Stockholm, Sweden (R. Kinnunen, opponent for doctoral thesis defence)

Meetings of CMS Finance and Collaboration Boards,
CERN, Geneva, Switzerland (J. Tuominiemi)

CMS Tracker

CERN RD50 - Full Detector Systems - Meeting,
28 February, Trento, Italy (talk by J. Härkönen)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (talks by P. Luukka, T. Mäenpää and E. Tuovinen)

CERN RD39 Workshop on Cryogenic Tracking Detectors I-2005,
1 June, Helsinki, Finland (talk by E. Tuovinen)

6th RD50 - Workshop on Radiation hard semiconductor devices for very high luminosity colliders,
2-4 June, Helsinki, Finland (talk by P. Luukka)

10th European Symposium on Semiconductor Detectors,
12-16 June, Wildbad Kreuth, Germany (talks by J. Härkönen, P. Luukka and E. Tuovinen)

11th International Conference on Defects-Recognition, Imaging and Physics in Semiconductors,
15-19 September, Beijing, China (talk by J. Härkönen)

RD05 - 7th International Conference on Large Scale Applications and Radiation Hardness of Semiconductor Detectors,
5-7 October, Florence, Italy (talk by T. Mäenpää)

CERN RD39 Workshop on Cryogenic Tracking Detectors II-2005,
11 November, CERN, Geneva, Switzerland (talk by J. Härkönen)

Nuclear Matter Programme

ALICE

CERN,
31 January, Geneva, Switzerland (talk by W. H. Trzaska)

ALICE ITS Week,
31 January - 3 February, CERN, Geneva, Switzerland (talk by M. Oinonen)

LHCC CR4,
1 February, CERN, Geneva, Switzerland (talk by W. H. Trzaska)

Niels Bohr Institute,
10 February, Copenhagen, Denmark (M. Oinonen)

ALICE Week,
28 February - 3 March, CERN, Geneva, Switzerland (talk by M. Oinonen)

ALICE Forum,
1 March, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

Physics Forum,
2 March, CERN, Geneva, Switzerland (invited talk by M. Bondila)

CERN,
7 March, Geneva, Switzerland (talk by W. H. Trzaska)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Espoo, Finland (talk by H. Seppänen, M. Bondila, M. Oinonen, S. Nikkinen, W. H. Trzaska)

FIN-ALICE 2005,
21 March, Jyväskylä, Finland (talks by M. Bondila, M. Oinonen, W. H. Trzaska)

Warsaw,
23 March, Warsaw, Poland (talk by W. H. Trzaska)

Comprehensive Review of T0 Electronics,
12 May, CERN, Geneva, Switzerland (talk by W. H. Trzaska)

ALICE ITS Week,
16-20 May, Jalta, Ukraine (talk by H. Seppänen)

SRTIIE Institute,
21-23 May, Kharkov, Ukraine (H. Seppänen)

Scientific Advisory Board Meeting of HIP,
24 May, CERN, Geneva, Switzerland (talk by M. Oinonen)

CERN,
2 June, Geneva, Switzerland (talk by M. Bondila)

ALICE Week,
13-16 June, Utrecht, The Netherlands (talk by Z. Radivojevic, invited talk by W. H. Trzaska)

PRR Meeting for T0,
11 July, CERN, Geneva, Switzerland (talk by W. H. Trzaska)

LECC'05,
12-16 September, Heidelberg, Germany (talk by M. Oinonen)

Colloquium, University of Jyväskylä,
23 September, Jyväskylä, Finland (talk by W. H. Trzaska)

CERN,
5 October, Geneva, Switzerland (talk by M. Bondila)

ALICE Week,
10-14 October, CERN, Geneva, Switzerland (talk by M. Oinonen)

ALICE Forum,
12 October, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

Particle Physics Day,
18 November, Jyväskylä, Finland (talk by M. Bondila)

The 1st ALICE Physics Week,
5-9 December, Erice, Italy (invited talk by W. H. Trzaska)

GSI / FAIR Meeting,
12-13 December, Darmstadt, Germany (M. Oinonen)

ISOLDE

Joint UK Nuclear and Particle Physics Meeting on the Beta-Beam task and First Meeting of the EURISOL Beta-Beam Task,
January, Rutherford Appleton Laboratory, UK (invited talk by J. Äystö)

The Annual Meeting of the Finnish Physical Society,
18 March, Espoo, Finland (talk by A. Jokinen)

Colloquium, University of Jyväskylä,
13 May, Jyväskylä, Finland (talk by A. Jokinen)

Workshop on Nuclear Physics and Astrophysics at CERN,
10-12 October, Geneva, Switzerland (talk by A. Jokinen, talk by J. Äystö)

Center of Excellence Scientific Board Meeting,
2 December, Jyväskylä, Finland (talk by A. Jokinen)

Technology Programme

The 2nd Nordic Grid Neighbourhood Workshop,
19-21 January, Tallinn, Estonia (talk by M. Gindonis)

1st JBoss World Conference,
1-2 March, Atlanta, GA, USA (invited talk by M. Tuisku)

EGEE All-Activity Meeting,
10-11 March, CERN, Geneva, Switzerland (talk by J. White)

Grid Seminar,
15 March, Lausanne, Switzerland (invited talks by M. Tuisku, T. Niemi)

The 3rd Nordic Grid Neighbourhood Workshop,
16-19 March, Vilnius, Lithuania (talks by M. Gindonis, M. Pitkänen)

Finnish Ambassador to Switzerland's visit at CERN,
11 May, CERN, Geneva, Switzerland (talk by M. Tuisku)

CCGrid 2005, Cluster Computing and Grid,
9-12 May, Cardiff, Wales, UK (J. Karppinen)

XV European-Japanese Conference on Information Modelling and Knowledge Bases,
16-19 May, Tallinn, Estonia (presentations by T. Niemi)

The 4th Nordic Grid Neighbourhood Workshop,
18-21 May, St-Petersburg, Russia (talk by M. Gindonis)

3rd EGEE Conference,
18-22 May, Athens, Greece (presentations by J. White, J. Hahkala)

CSCS Grid Meeting,
15 June, Manno, Switzerland (talks by J. Klem, M. Pitkänen)

University of Lugano Grid Meeting,
16 June, Lugano, Switzerland (talks by M. Tuisku, M. Pitkänen)

The 1st Nordic Grid Neighbourhood Conference,
15-17 August, Oslo, Norway (J. Klem, talk by T. Niemi)

NorduGrid Meeting,
17-19 August, Oslo, Norway (talk by J. Klem)

World e-ID 2005 Conference,
21-23 September, Sophia Antipolis, France (H. Mikkonen)

GridWorld, 14th Global Grid Forum Conferences,
3-6 October, Boston, MA, USA (J. Hahkala)

Grids@work - 2nd GRID Plugtests,
10-14 October, Sophia Antipolis, France (M. Tuisku)

6th Annual Workshop on Linux Clusters for Super Computing,
17-19 October, Linköping, Sweden (talk by K. Happonen)

4th EGEE Conference,
24-28 October, Pisa, Italy (J. Hahkala, J. White)

Geant4 User Conference,
3-5 November, Bordeaux, France (J. Klem)

JBoss World Conference,
10-12 November, Barcelona, Spain (J. Karppinen)

JavaPolis Conference,
12-16 December, Antwerp, Belgium (T. Nissi)

Administration and Support

EPOG Meeting,
8-9 April, Valencia, Spain (R. Rinta-Filppula)

CERN Co-operation High School Network Seminar,
9 September, Jyväskylä, Finland (invited talk by R. Rinta-Filppula)

EPOG Meeting,
28-29 November, CERN, Geneva, Switzerland (R. Rinta-Filppula)

Publications

Theory Programme

Cosmology

K. Enqvist, S. Hannestad and M. S. Sloth,
Searching for a holographic connection between dark energy and the low *l* CMB multipoles,
J. Cosmol. Astropart. Phys. 0502 (2005) 004

K. Enqvist, A. Jokinen, A. Mazumdar, T. Multamäki and A. Väihkönen,
Non-Gaussianity from instant and tachyonic preheating,
J. Cosmol. Astropart. Phys. 0503 (2005) 010

K. Enqvist, A. Jokinen, A. Mazumdar, T. Multamäki and A. Väihkönen,
Cosmological constraints on string scale and coupling arising from tachyonic instability,
J. High Energy Phys. 0508 (2005) 084

K. Enqvist, A. Jokinen, A. Mazumdar, T. Multamäki and A. Väihkönen,
Non-Gaussianity from preheating,
Phys. Rev. Lett. 94 (2005) 161301

K. Enqvist and S. Nurmi,
Non-Gaussianity in curvaton models with nearly quadratic potentials,
J. Cosmol. Astropart. Phys. 0510 (2005) 013

E. Keihänen, H. Kurki-Suonio and T. Poutanen,
MADAM - a map-making method for CMB experiments,
Mon. Not. R. Astron. Soc. 360 (2005) 390

T. Koivisto,
Growth of perturbations in dark matter coupled with quintessence,
Phys. Rev. D 72 (2005) 043516

T. Koivisto, H. Kurki-Suonio, F. Ravndal,
CMB spectrum in Cardassian models,
Phys. Rev. D 71 (2005) 064027

H. Kurki-Suonio, V. Muhonen and J. Väliviita,
Correlated primordial perturbations in light of CMB and large scale structure data,
Phys. Rev. D 71 (2005) 063005

D. Langlois, and F. Vernizzi,
From heaviness to lightness during inflation,
J. Cosmol. Astropart. Phys. 0501 (2005) 002

D. Langlois, and F. Vernizzi,
Conserved nonlinear quantities in cosmology,
Phys. Rev. D 72 (2005) 103501

D. Langlois, and F. Vernizzi,
Evolution of nonlinear cosmological perturbations,
Phys. Rev. Lett. 95 (2005) 091303

F. Vernizzi,
Conservation of second-order cosmological perturbations in a scalar field dominated universe,
Phys. Rev. D 71 (2005) 061301(R)

Laser Physics and Quantum Optics

A. Collin, E. Lundh, and K.-A. Suominen,
Center-of-mass rotation and vortices in an attractive Bose gas,
Phys. Rev. A 71 (2005) 023613

M. Mackie, A. Collin, and J. Javanainen,
Comment on "Stimulated Raman adiabatic passage from an atomic to a molecular Bose-Einstein condensate",
Phys. Rev. A 71 (2005) 017601

Particle Physics Phenomenology

S. J. Brodsky, R. Enberg, P. Hoyer and G. Ingelman,
Hard diffraction from parton rescattering in QCD,
Phys. Rev. D 71 (2005) 074020

E. Gabrielli, K. Huitu, S. Khalil,
Comparative study of CP asymmetries in supersymmetric models,
Nucl. Phys. B 710 (2005) 139

P. Hoyer,
Rescattering in DIS and other QCD processes,
Eur. Phys. J. A 24 (2005) s01, 137

P. Hoyer and M. Järvinen,
Soft rescattering in DIS: effects of helicity flip,
J. High Energy Phys. 0510 (2005) 080

K. Huitu, J. Laamanen, P. N. Pandita, and S. Roy,
Phenomenology of nonuniversal gaugino masses in supersymmetric grand unified theories,
Phys. Rev. D 72 (2005) 055013

K. Huitu, J. Laamanen, P. Roy, and S. Roy,
Infrared fixed point of the top Yukawa coupling in split supersymmetry,
Phys. Rev. D 72 (2005) 055002

M. Järvinen,
Hydrogen atom in relativistic motion,
Phys. Rev. D 71 (2005) 085006

Hadron Physics Activity

F. Frömel, B. Juliá-Díaz, D. O. Riska,
Bound states of heavy flavor hyperons,
Nucl. Phys. A 750 (2005) 337

J. Gasser, M. A. Ivanov, M. E. Sainio,
Low-energy photon-photon collisions to two loops revisited,
Nucl. Phys. B 728 (2005) 31

A. M. Green and S. Wycech,
η-nucleon scattering length and effective range uncertainties,
Phys. Rev. C 71 (2005) 014001; Erratum, ibid., C 72 (2005) 029902(E)

J. He, B. Juliá-Díaz, and Y.-B. Dong,
Electroweak properties of the π, K and K*(892) in the three forms of relativistic kinematics,
Eur. Phys. J. A 24 (2005) 411

B. Juliá-Díaz and D. O. Riska,
***D*-state configurations in the electromagnetic form factors of the nucleon and the Δ(1232) resonance,**
Nucl. Phys. A 757 (2005) 441

D. Jurčiukonis, E. Norvaišas, D. O. Riska,
Canonical quantization of SU(3) Skyrme model in a general representation,
J. Math. Phys. 46 (2005) 072103

M. E. Sainio,
Pion-nucleon interaction and the strangeness content of the nucleon,
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B. S. Zou, D. O. Riska,
$s\bar{s}$ component of the proton and the strangeness magnetic moment,
Phys. Rev. Lett. 95 (2005) 072001

Physics of Biological Systems

E. Falck, M. Patra, M. Karttunen, M. T. Hyvönen, I. Vattulainen,
Response to comment by Almeida et al.: Free area theories for lipid bilayers - predictive or not?,
Biophys. J. 89 (2005) 745

A. A. Gurtovenko,
Asymmetry of lipid bilayers induced by monovalent salt: atomistic molecular-dynamics study,
J. Chem. Phys. 122 (2005) 244902

A. A. Gurtovenko and A. Blumen,
Generalized Gaussian structures: models for polymer systems with complex topology,
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A. A. Gurtovenko, M. Miettinen, M. Karttunen, and I. Vattulainen,
Effect of monovalent salt on cationic lipid membranes as revealed by molecular dynamics simulations,
J. Phys. Chem. B 109 (2005) 21126

A. A. Gurtovenko and I. Vattulainen,
Pore formation coupled to ion transport through lipid membranes as induced by transmembrane ionic charge imbalance: atomistic molecular dynamics study,
J. Am. Chem. Soc. 127 (2005) 17570

M. T. Hyvönen, P. T. Kovanen,
Molecular dynamics simulations of unsaturated lipid bilayers: effects of varying the numbers of double bonds,
Eur. Biophys. J. 34 (2005) 294

M. Kupiainen, E. Falck, S. Ollila, P. Niemela, A. A. Gurtovenko, M. T. Hyvonen, M. Patra, M. Karttunen, and I. Vattulainen,
Free volume properties of sphingomyelin, DMPC, DPPC, and PLPC bilayers,
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M. Mašín, I. Vattulainen, T. Ala-Nissila, and Z. Chvoj,
Nonequilibrium effects in diffusion of interacting particles on vicinal surfaces,
J. Chem. Phys. 122 (2005) 214728

O. Punkkinen, E. Falck, I. Vattulainen, T. Ala-Nissila,
Dynamics and scaling of polymers in a dilute solution: analytical treatment in two and higher dimensions,
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O. Punkkinen, P. L. Hansen, L. Miao, I. Vattulainen,
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Biophys. J. 89 (2005) 967

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Modeling glycolipids: take one,
Cell. Mol. Biol. Lett. 10 (2005) 625

E. Salonen, E. Terama, I. Vattulainen, and M. Karttunen,
Dielectrophoresis of nanocolloids: a molecular dynamics study,
Eur. Phys. J. E 18 (2005) 133

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I. Vattulainen,
Molecules dancing in membranes,
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M. Warrier, R. Schneider, E. Salonen, and K. Nordlund,
Multi-scale modeling of hydrogen isotope transport in porous graphite,
J. Nucl. Mater. 337-339 (2005) 580

String Theory and Quantum Field Theory

V. Balasubramanian, E. Keski-Vakkuri, P. Kraus, A. Naqvi,
String scattering from decaying branes,
Commun. Math. Phys. 257 (2005) 363

M. Chaichian and A. Kobakhidze,
Deformed N = 1 supersymmetry,
Phys. Rev. D 71 (2005) 047501

M. Chaichian, P. Prešnajder, and A. Tureanu,
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S. Hemming, S. Kawai and E. Keski-Vakkuri,
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P. S. Howe, U. Lindström and L. Wulff,
Superstrings with boundary fermions,
J. High Energy Phys. 0508 (2005) 041

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Generalized Kähler geometry and manifest *N*=(2,2) supersymmetric nonlinear sigma-models,
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Ultrarelativistic Heavy Ion Collisions

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K. J. Eskola, H. Honkanen, H. Niemi, P. V. Ruuskanen, and S. S. Räsänen,
Predictions for low-p_T and high-p_T hadron spectra in nearly central Pb+Pb collisions at $\sqrt{s_{NN}}$ =5.5 TeV tested at $\sqrt{s_{NN}}$ =130 and 200 GeV,
Phys. Rev. C 72 (2005) 044904

K. J. Eskola, H. Honkanen, C. A. Salgado, U. A. Wiedemann,
The fragility of high-p_T hadron spectra as a hard probe,
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F. Gelis, K. Kajantie, and T. Lappi,
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Phys. Rev. C 71 (2005) 024904

A. Hietanen, K. Kajantie, M. Laine, K. Rummukainen and Y. Schröder,
Plaquette expectation value and gluon condensate in three dimensions,
J. High Energy Phys. 0501 (2005) 013

P. Huovinen,
Anisotropy of flow and the order of phase transition in relativistic heavy ion collisions,
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Dissipation and elliptic flow at relativistic energies,
Phys. Rev. Lett. 94 (2005) 012302

A. Rebhan, P. Romatschke, M. Strickland,
Dynamics of quark-gluon-plasma instabilities in discretized hard-loop approximation,
J. High Energy Phys. 0509 (2005) 041

A. Rebhan, P. Romatschke, and M. Strickland,
Hard-loop dynamics of non-Abelian plasma instabilities,
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Orientifold theory dynamics and symmetry breaking,
Phys. Rev. D 71 (2005) 051901(R)

High Energy Physics Programme

Electron-Positron Physics

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J. Abdallah et al.,
Photon events with missing energy in e^+e^- collisions at $\sqrt{s}$ =130 to 209 GeV,
Eur. Phys. J. C 38 (2005) 395

J. Abdallah et al.,
Measurement of the energy dependence of hadronic jet rates and the strong coupling α_s from the four-jet rate with the DELPHI detector at LEP,
Eur. Phys. J. C 38 (2005) 413

J. Abdallah et al.,
Determination of A_{FB}^b at the Z pole using inclusive charge recontruction and lifetime tagging,
Eur. Phys. J. C 40 (2005) 1

J. Abdallah et al.,
Flavour independent searches for hadronically decaying neutral Higgs bosons,
Eur. Phys. J. C 44 (2005) 147

J. Abdallah et al.,
Coherent soft particle production in *Z* decays into three jets,
Phys. Lett. B 605 (2005) 37

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J. Abdallah et al.,
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Eur. Phys. J. C 44 (2005) 161

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Production of Ξ_c^0 and Ξ_b in Z decays and lifetime measurement of Ξ_b,
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Charged particle multiplicity in three-jet events and two-gluon systems,
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Forward Physics

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